DECEMBER, 1961
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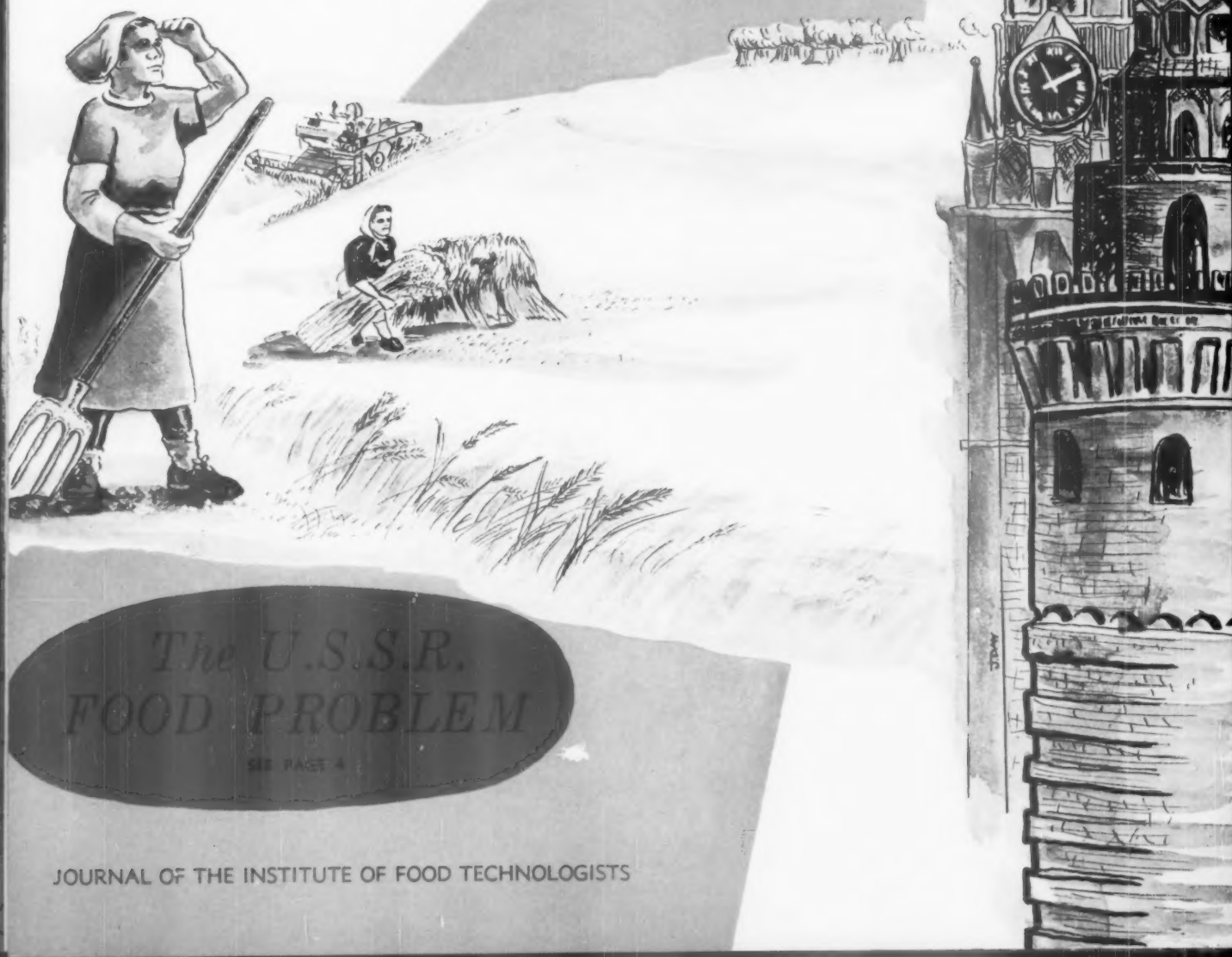
FT food technology



The U.S.S.R. FOOD PROBLEM

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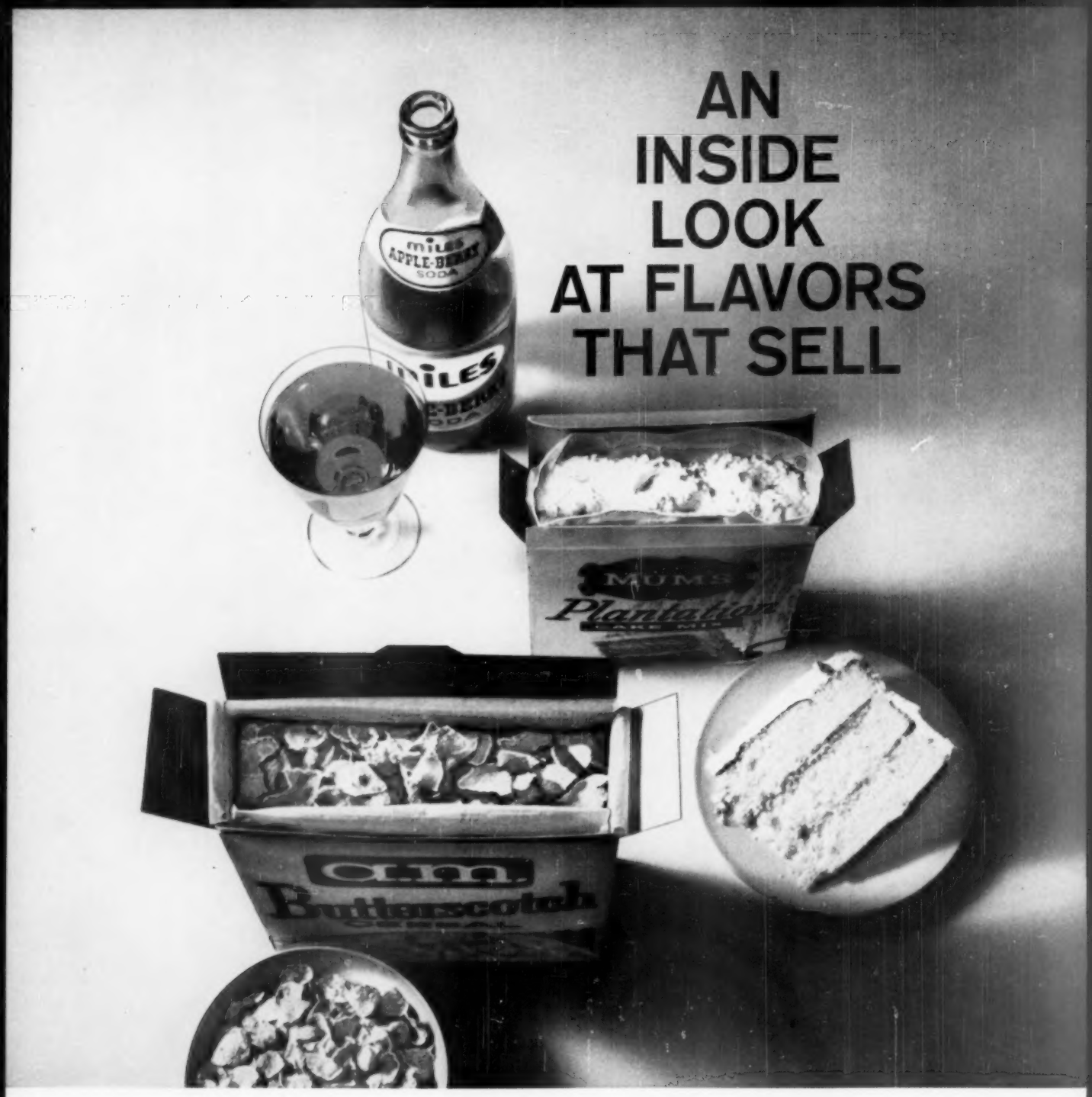

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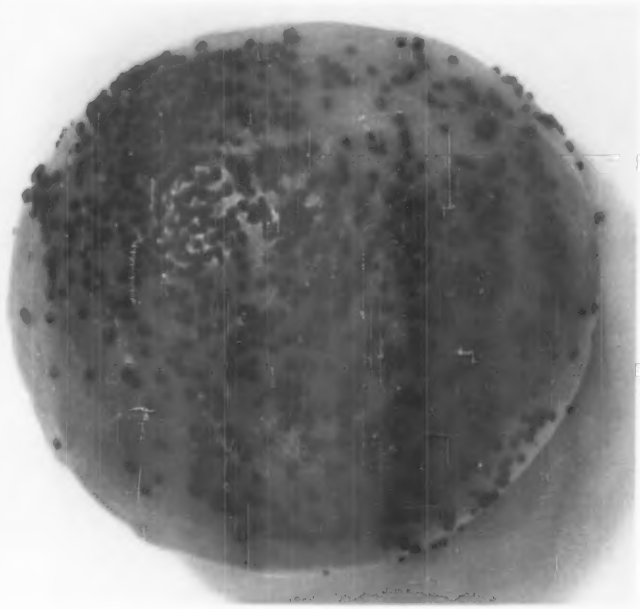

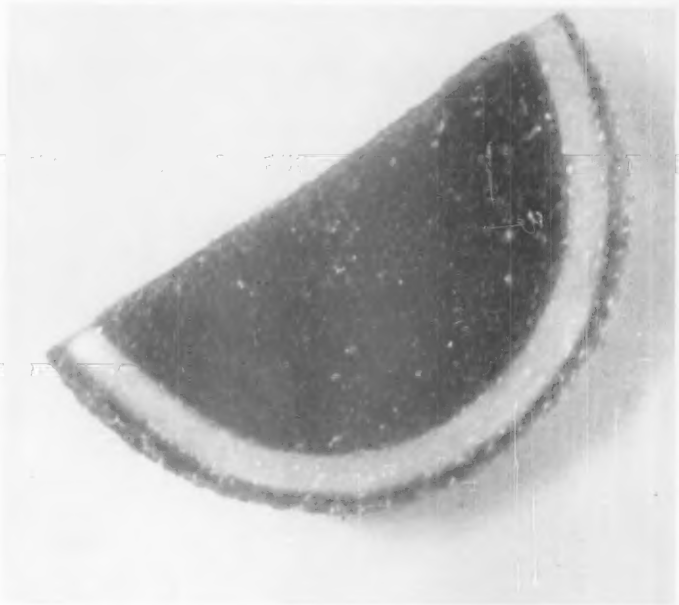

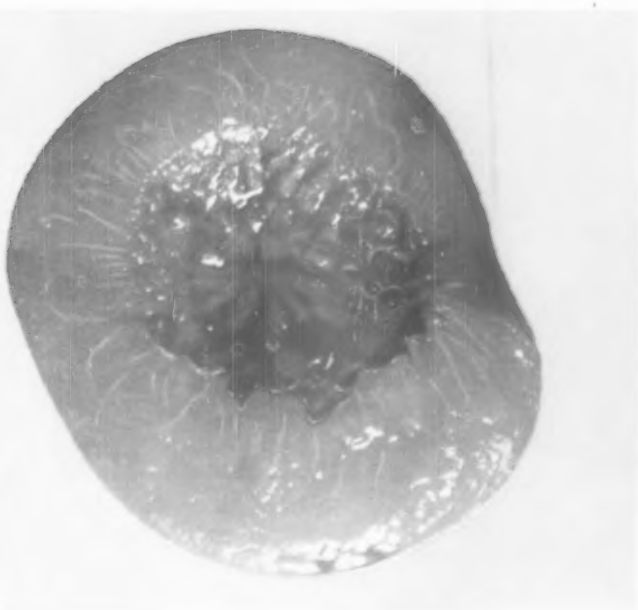

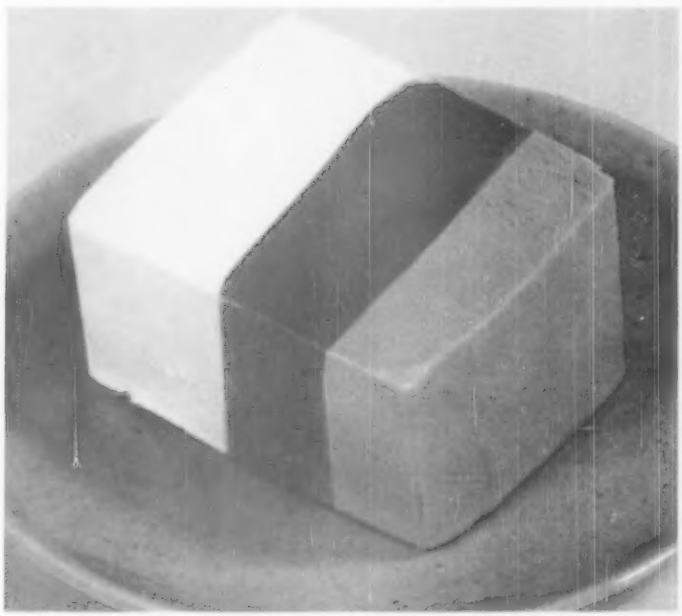

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The U.S.S.R. Food Problem

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THE TITLE assumes that the authors know precisely what the Russian food problem is and how the Russians are proposing to solve it. This is hardly true, for it is very difficult to get accurate information from a proud nation where restricted flow of information is a national policy. Even so it may be possible for us to offer in general terms an appraisal of the Russian food situation. What we report here is the result of our participation in a U. S. mission to the U.S.S.R. to study what that country is doing to try to get more and better food to its people. The views are our own, yet we must acknowledge our indebtedness to other members of our group. These were Dr. G. E. Hilbert, Foreign Agricultural Service, and Dr. Omer W. Herrmann, Agricultural Marketing Service, both of the U. S. Department of Agriculture; Mr. Milan Smith, National Canners Association and Smith Canning and Freezing Company; Mr. David Levitt, DCA Industries, Inc.; and Mr. Robert MacLellan, Food Machinery International. Our group represented the viewpoints of government, education, and industry and the disciplines of the natural sciences, economics, and management.

The people of the U.S.S.R.

Food is for people—and so, a few words about the population to be fed. There are approximately 215,000,000 people in the U.S.S.R. but they are not nearly as homogeneous as the population of the U.S.A. The several so-called "republics" are nationalistic groups that may differ in customs, languages, and even alphabets, and yet are under the control of the Moscovite Russians. Half of the people are directly involved in farming to produce the necessary food for all. More than half are essentially uneducated and subsist on a very low economic and social plane, with little opportunity to better themselves. About 2–3% make up the Communist party, the ruling class. Then there is a larger bourgeois group composed of educated people who get paid well for what they know and can do, and a small proportion of this group aspire to the ruling class. The people in the U.S.S.R. were most hospitable, and the average Soviet citizen is much interested in America—particularly living conditions of the average American family.

Housing is critically short

In the cities, space is rationed at 120–140 sq ft for the head of the family and 75–86 sq ft for each dependent. Bath and kitchen must usually be shared with 1, 2, or 3 other families. In the rural areas, families generally live in 1- and 2-room cottages without plumbing and electricity. Wages are lower in rural areas than in the cities, but farm workers are permitted to rent a garden plot of about 0.40 acre (in some parts of the U.S.S.R. these gardens have approached 1 acre but are now being reduced to the smaller figure). These gardens contribute not only to the total food supply but to its quality, because a cow, pig, or a few chickens can be supported for the farm family's use.

Food prices

Housing costs ($6–10 per month for workers in the cities) require a small portion of the family income in comparison to food and clothing, both of which are relatively quite expensive. This of course reflects scarcity of these essential commodities.

Table 1. Some selected food prices in Russia.

Simple white bread	$0.06/lb
Long white loaf (5% fat, 5% sugar)	.15/lb
Rye bread (6% malted rye)	.06/lb
Sugar	.40/lb
Margarine	1.30/lb
Cheese	1.48/lb
Hamburger	.77/lb
Wieners	.68/lb
Pork chop (including fat back and belly strip)	1.30/lb
Ham, cooked but untrimmed	1.55/lb
Canned meat and peas (30% meat)	1.20/lb
Canned fish	.90/lb
Canned fruit, No. 2½ can	1.05
No. 2 can	.69
Canned vegetables: peas, carrots, tomatoes, No. 2 can	.60
Ice cream cone	.20
1 piece chocolate candy, bite size	.15
Chocolate bar, our 25¢ size	1.25
1 orange, large	.60

There is just about enough food to satisfy most of the energy requirements of the population, but there are shortages of high-quality protein foods and food fats. The food grains of wheat, rye, buckwheat, oats, and barley form the hard core of the Russian food supply, the basis of a rather monotonous diet of porridge and bread. Table 1 gives an idea of costs, which are an indication of which foods are in short supply. From these prices it is at once apparent that most of the population cannot afford much processed food, particularly when it is considered that unskilled workers in the cities are paid up to $50–60 per month (Table 2) and the level of wages in the rural areas may run as low as $10–30 per month. Consequently, in many areas the most primitive methods of food preservation are practiced within the worker's family—that is, fermentation, brining, freezing in winter, and drying. Home canning is still beyond the means of most farm families. Yet in the cities one finds that processed foods are being used to a much

Table 2. Summary of wages in Russia.

Directors of farms, plants and institutes	$400–500/month, plus many fringe benefits, such as car, contingency funds
Laboratory or division heads, professors, D.Sc., or persons of long practical experience	$320–380/month
Senior scientists (candidate, equivalent to Ph.D.)	$250/month
Foremen and skilled workers	$100–150/month
Unskilled workers, city	$40–60/month
Farm workers	
(a) Given by Soviet authorities	$40–60
(b) Reported by the farmers	$10–30

greater extent by the higher-income groups—skilled workers, business and professional people, etc. Because of the very high cost of foods and the inadequate supply of high-quality nutrients, some disparity of nutritional states exists in the general population. Obesity is not at all uncommon in higher-income groups.

Wages and salaries

Table 2 briefly summarizes wages and salaries, and illustrates the great differentials in income that exist among the Soviet citizens. Directors' salaries are usually 10–15 or more times as great as the salaries of their workers, and in addition directors often get other benefits equal to their salary. These include bonuses for meeting or exceeding production quotas, a car, entertainment, and other allowances. Some clothing and other prices (Table 3) clearly indicate

Table 3. Prices of some clothing and other items in Russia.

Man's suit	$170–250
Slacks, $7 quality in U. S.	30–40
Man's shirt, $2 quality in U. S.	8–10
Shoes, men's	30–50
Shoes, women's	20–40
Bicycle	70–90
Car	2500–4800
Voice box for state radio	5

the shortage of cotton and wool. Reflection on Tables 1, 2, and 3 will make clear the reasons for the disparity referred to above and for the wide spectrum of living standards among the people.

Basic food situation

Table 4 gives statistical data on the production of basic foodstuffs in the U.S.S.R. The data indicate that the U.S.S.R. is basically a grain producer. Disregarding corn production, the total grain output of the U.S.S.R. in 1959 was 113.9 million metric tons, versus 72.0 million tons in the U.S.A. Potatoes are produced in larger quantities in the U.S.S.R. than in this country. The total output of milk and sugar is comparable to that in the United States. However, the Soviet Union has over 215 million people to feed, versus 180 million in this country. The very low production of butter indicates that milk is consumed in the Soviet Union mainly as fluid milk products and cheese. From observations in dairy plants, on the farms, and in the cities, it appears that the figure for total milk produced in the U.S.S.R. is high.

Table 4. Production of basic foodstuff in the U.S.S.R. and the United States.

Foodstuff	U.S.S.R.[a]	United States[b]	Year
	(million metric tons)		
1. Total grains	125.9	183.0	1959
(a) Wheat	69.1	30.7	
(b) Corn	12.0	111.0	
2. Soybeans	0.8[c]	14.7	1959
3. Potatoes	86.6	11.1	1959
4. Vegetables[d]	14.8	17.3	1959
5. Fruit and berries[e]	5.19	16.48	1959
(a) Grapes	1.73	2.85	
6. Sugar	5.00[f]	4.57	1959
7. Milk	62.0	56.5	1959
8. Butter	0.8	13.9	1959
9. Eggs (billions)	25.0	62.4	1959
10. Meat—total production			
(All meats + poultry + lard)	8.9	16.9	1959
	6.2[g]		
U.S.S.R. state packing houses	3.7[h]		1959
(a) Beef	1.60[i]	6.63[j]	
(b) Pork	1.23[k]	5.50	
(c) Lamb and mutton	0.76	0.34	
(d) Poultry	0.11	3.14[l]	
(e) Lard	[i]	1.29	

[a] "Selskoye Khozyaistvo S.S.S.R., Statisticheskii Sbornik" (Agriculture of the U.S.S.R., Statistical Book), Central Statistical Office at the Council of Ministers of the U.S.S.R., Gosstatizdat, TaSU, S.S.S.R., Moscow, 1960.

[b] Agricultural Statistics, 1960. U. S. Department of Agriculture.

[c] Estimated amount, based on the harvested average acreage for 1950–54: U.S.S.R., 813,000 acres; United States, 14,747,000 acres (U.S.D.A. Agr. Statistics, 1960).

[d] U. S. commercial production only.

[e] Twenty fruits only, in the case of the United States.

[f] Director's information, All-Union Central Scientific Research Institute of Sugar Industry, Kiev, U.S.S.R., July 6, 1960.

[g] U.S.D.A. Foreign Agricultural Service estimate (Agr. Statistics, 1960).

[h] *Myasnaya Ind. S.S.S.R. 31*, No. 3, 5–6 (1960).

[i] Farm slaughter not included. Estimated figures, based on values of 51.2, 33.3, 12.5, and 3.0% for beef, pork, lamb and mutton, and poultry, respectively [*Myasnaya Ind. S.S.S.R. 30*, No. 4, 1–5 (1959)].

[j] Livestock and Meat Statistics, Statistical Bulletin No. 230, U. S. Department of Agriculture, June 1960.

[k] Including lard, estimated at 135 million pounds (0.06 million metric tons).

[l] The Poultry and Egg Situation. PES-211, U. S. Department of Agriculture, June 1960.

Credence to this view is seen from data available on meat (see above).

The shortage of food protein in the U.S.S.R. is indicated by the low production of meat and eggs, only about one-third to one-half of United States production of these foods. This comparison would be valid if Russian statistics could be taken at face value. However, directors of Russian state farms and chairmen of the collective farms are responsible for fulfillment of the delivery quotas to the state. This forces them to raise production statistics as high as possible. There are known examples of purchases in state stores being made by collective farms and resold again to the state to meet delivery quotas.

The data for meat production in the Soviet Union give cause to question the validity of these Soviet figures. The Soviet Agricultural Statistics Book for 1960 indicates a total meat output of 8.9 million metric tons. At the same time the Russian meat journal [*Myasnoya Ind. S.S.S.R. 30*, No. 3, 5–6 (1960)] indicates that the meat output in the state-owned slaughter houses was 3.7 million tons. This means that 5.2 million tons of meat, poultry, and lard were produced and consumed on the farms. The Soviet state doesn't have privately owned farms, and only the collective farm workers are allowed to have privately owned garden plots. This land is usually used

Main gate of Mikoyan Meat Combine, Moscow.

to grow potatoes and vegetables with which the farmers can feed not more than one hog per family per year. There are 18.6 million collective farm households in the Soviet Union. This means that a maximum of 18.6 million hogs, or their equivalent (such as sheep in the Asiatic parts of the U.S.S.R.) can be produced in the U.S.S.R. in addition to the state meat delivery. With about 200 lb per hog this would amount to 1.7 million metric tons of additional meat output. About one-fifth of the Soviet rural population works on state farms. They may receive about 0.3–0.4 million metric tons of meat for home consumption from the state farms, prior to the state delivery of livestock. Therefore, an additional meat output of 2.0–2.1 million metric tons is a reasonable estimate. This would account for about 5.7 million metric tons as the total meat output in the Soviet Union in 1959. The U. S. Agricultural Foreign Service estimate of 6.2 million tons (Table 4) represents the greatest figure possible. Consequently the meat production of the Soviet Union, including poultry and lard, is about 37% of U. S. production. The present Russian meat and lard output corresponds roughly to U. S. production in 1930. The present annual increase in the meat delivery to the state is 5.5% [3.9 versus 3.7 million metric tons for the year 1960 versus 1959; *Myasnoya Ind. S.S.S.R.* 32, No. 1, 4–5 (1961)]. The shortage of animal feeds (see corn and soybean production in the U.S.S.R., Table 4) is the main obstacle to an increase in animal-foods output in the U.S.S.R.

The total output of canned foods, including meats, in the U.S.S.R. is only 4.3 billion standard (400-g) cans per year. However, this branch of the Russian food industry can expand rapidly if the state gives the proper support and if the prices of the canned foods could be lowered so that more Soviet citizens could afford to purchase them.

The Soviet food specialists, directors of the plants, and the scientists working in the field, are quite competent in their jobs and know how to make good food products from the raw material available to them. The topography of the land, the climate, and working conditions in the rural areas are some of the major limiting factors for food production in the Soviet Union.

Emphasis on science and technology by the Soviets may diminish some of these food deficiencies in the future. There are at present 33,821 people engaged in veterinary, food, and biological sciences related to agriculture in the Soviet Union. Seven agricultural academies, 202 scientific research institutes and their branches, 433 agricultural experimental stations, 123 experimental teaching stations, and 71 related establishments are available to these Russian agricultural and food specialists who are working to produce more and better foods for the Soviet people (U.S.S.R. Agr. Statistics, 1960).

Some of the Russian food scientists are well known for their achievements in the world, and it was good to meet them and share ideas with them. These men are indeed dedicated to doing everything possible to improve the food situation in the U.S.S.R. They were most cordial and hospitable, and are quite anxious to establish closer contact with their professional colleagues abroad. In this respect our mission was a success, and it is hoped that such missions will be continued in the future.

Food industries

Meats are scarce, and over 50% is made into sausage because there is little or no refrigeration at the retail and home levels. Furthermore, meats are priced and bought more for the fat than for the lean, since fats are so short in supply. Processes for recovery of edible fat from bones, grape seeds, and cherry seeds are in commercial practice or are being investigated. One large well mechanized meat plant could easily double its output of product without increasing its labor force or equipment if suitable animals were available. Many small and malnourished animals were being slaughtered when we were there, reflecting the fact that a severe lack of feed seemed to be the dominant factor over the Russian desire to build up breeding stock or the requirement that a certain tonnage must be delivered to the state at a fixed time. The most reliable figures indicate that per capita meat consumption in the U.S.S.R. is only 30–35% of that in the U.S.A. However, since these figures include lard and poultry, it is perhaps more accurate to say that the average Russian eats no more than one-fourth of the red meat that the average American consumes.

Milk consumption is perhaps a bit higher. Over half of the milk is consumed as fermented dairy products such as acidophilus milk, yogurt, kumys, etc. Furthermore the climate in much of the U.S.S.R. cannot support dairying, so milk is dried and shipped long distances. There may be large milk-reconstituting plants rather than pasteurizing plants. They are working to perfect a process of injecting viable cultures just as milk is dried so that if the consumer wants fresh milk he reconstitutes with hot water to kill the culture, or if he wants yogurt he reconstitutes with warm water and incubates for a short time.

Vegetables, except potatoes and cabbage, and fruits are in short supply, and canned fruits and vegetables are very expensive. The Russian canning industry produces less than 10% of the U. S. per capita requirement. The canning industry as we saw it is not nearly as modern as ours, though we did see one fairly modern operation; it depended on water transport for its supply of raw materials—tomatoes, squash, peas, etc. According to the director of this plant, the plant grossed $22,000,000 in 1959 and turned over a net profit to the state of $1,825,000. (Thirty percent of all profits over the required 8% may be diverted toward workers' housing.) At another plant, cans were being made by hand. Frozen fruits and vegetables are almost non-existent for the ordinary Russian.

To get high-quality protein they have turned to the sea, and their factory ships and accompanying trawlers probably make up the world's most modern fishing fleets. The fish are frozen in large blocks, which are broken down for distribution at the retail level. Fish are not nearly making up for the general deficiency of high-quality proteins, however.

Our look at the baking industry indicated rather efficient operation. The average Russian eats 6 times as much bread as the average American. Russian bread, made of very hard native wheats, is delicious when fresh but stales rapidly. Bread and other bakery items are among the cheapest foods, a sort of morale booster, and retail outlets in some areas may get as many as 8 deliveries of fresh bread daily.

Speaking of morale, the Russians are acutely aware of the importance of beverages in this connection. They are attempting to develop a coffee industry and a taste for coffee in the Russian masses. Good tea can be grown in certain areas. They are playing down heavy alcoholic beverages and placing a great deal of emphasis on soft drinks, which are different from ours. Some are quite good, and many of the fruit drinks are made by making an alcohol extract of fruit such as raspberries. The extracts are simply diluted with carbonated water containing some sugar, and perhaps vegetable color and fruit acids. The finished drink has 1–1½% alcohol. There is cold kwas—a fermented sweet malty drink containing 1% alcohol, and made from stale and toasted bread. It is a favorite summer drink and is sold from small tanks by the cupful on the street corners. Some distain was expressed for the American cola drinks, and the Russians are trying to develop a soft drink made from native plants. It has a mild stimulatory action and is called "soyami." Bottled carbonated spring waters are popular.

The Russian government never lets an opportunity pass to impress upon the people that they are better off now than before and that the government has the interests of the masses uppermost in its policies. This attitude is displayed in putting the formula and net weight very prominently on the labels of processed foods to assure the consumer that even though food may be scarce, the consumer is getting his money's worth. However, the quality control measures in some places were not too impressive. Nutritional values are also emphasized—particularly in baby foods, which by American standards are produced on a very minor scale. There is an awareness that nutrition of the population must be improved. Small children get preferential treatment in getting milk and dairy products, and there is some production of blood candy and blood elixirs to be eaten by young children as sources of iron. The fortification of foods with vitamins is not common. The general population does not seem to be as aware of modern nutrition as Americans, and the Russian masses are prone to consider with suspicion the use of synthetic or highly refined nutrients.

One of the buildings of Mikoyan Food Combine, Moscow.

The sociological problem in food production

The foregoing remarks have implied that many of the Russian food problems might have a sociological as well as scientific significance. That is certainly true. Everyone is involved somehow. The city dwellers feel that food shortages are due to cheating, laziness, or stealing on the part of the rural population, as the cartoon (Fig. 1) implies. Certainly this is true in a very real way when it is considered that one-half of the people must work to grow the crops to feed themselves and the other half, and that these peasants are so poorly paid that "organizing" the state is practiced extensively. See Tables 1, 2, and 3. Premier Khrushchev paid much attention to this problem in a speech to his agricultural ministers in March, 1961.

Most permanent sociological changes come by mass education and persuasion rather than being ordered from above; and they are not amenable to as rapid change and manipulation as in a scientific development, where fewer people are involved. So, as we attempt to gain some perspective on Russian food problems, we can see some excellent progress in processing of food and somewhat less progress in the production of food crops. And in that country of sophisticated sputniks and large masses of uneducated citizens there is a broad spectrum of activities in the U.S.S.R. in trying to use all available resources to feed themselves. These include, of course, research

Fig. 1. "If you ask them why so few poultry on the farm. . . . they will paint for you this picture" ("Krokodil," July, 1960).

institutes to find the way, educational institutions to train key people, planning institutes to make the best use of available resources of manpower, capital and knowledge, farms to produce the food, processing and distributing facilities, and finally the consumers, who in themselves represent a wide spectrum of individual purchasing power.

Education

Education plays a dual role in any political and sociological upheaval. In the history of the United States its role is dominant, and some historians have suggested that the development of the American way of life is based on universal education of our people. We were the first large group of people to attempt mass education and to offer higher education to all the population. The U.S.S.R. still has a long way to go in this area, but even so, two clearly definable functions of education are much in evidence. First, there is the education of scientists, linguists, historians, economists, etc., who have the imagination and ability and who can assume the responsibility for creating and carrying on the various programs upon which a growing and changing society may be based. Second, there is the education of technicians to execute the programs as they develop. The famous Moscow University and similar institutions of higher learning have a great responsibility and challenge in the most basic and general areas. There are institutions of higher learning that carry a major burden in certain areas, such as the Moscow Technological Institute of the Food Industry, which has about 3000 students. This institution has responsibilities of teaching, service, and research not unlike our own Land-Grant state universities. The faculty members spend about one-half their time in research or service to industrial groups or to the Ministries of Trade and Health, and one-half their time in teaching. They have graduate as well as undergraduate programs, and their graduates have comparable standing with those of other institutions of higher learning. According to the deputy director this Institute has had the authority for three decades to confer the title of candidate (equivalent to the American Ph.D.) and titles of Professor or Doctor, which are singularly reserved for those of outstanding accomplishment.

Then there is, for example, the All-Union Institute for the Training of Milling Experts. Students attending must be 10th-grade graduates and have at least 3 years of practical mill experience. They are usually 22–35 years old and may study flour milling, feed milling, or porridge milling. Model mills and a commercial mill are part of the Institute facilities, and the courses are 50% theory and 50% practice. In addition to these students in courses, who, incidentally, are paid continuously by their home mills, the Institute has short-course programs for graduate engineers, who are sent to apply their disciplines to the milling industry; mill directors; laboratory directors for the milling industry; and regional planning chiefs for the milling industry.

There are other special schools for directors of food-processing plants of other types, for farm directors, and for administrators of other kinds.

Research institutes

Although these educational institutions do some research, there are many research institutions with special responsibilities for industrial development. There are the so-called All-Union Research Institutes and also the research institutes concerned with the local problems of the "republics." These institutes serve the meat, baking, milling, fruit and vegetable, fats and oil industries, and there are similarities in their organization and function. They have the usual scientific groups that we in the U. S. usually associated with a research organization—chemistry, physics, microbiology and engineering sections; but in addition they have large economics groups, scientific intelligence groups (translators, etc.), large technology

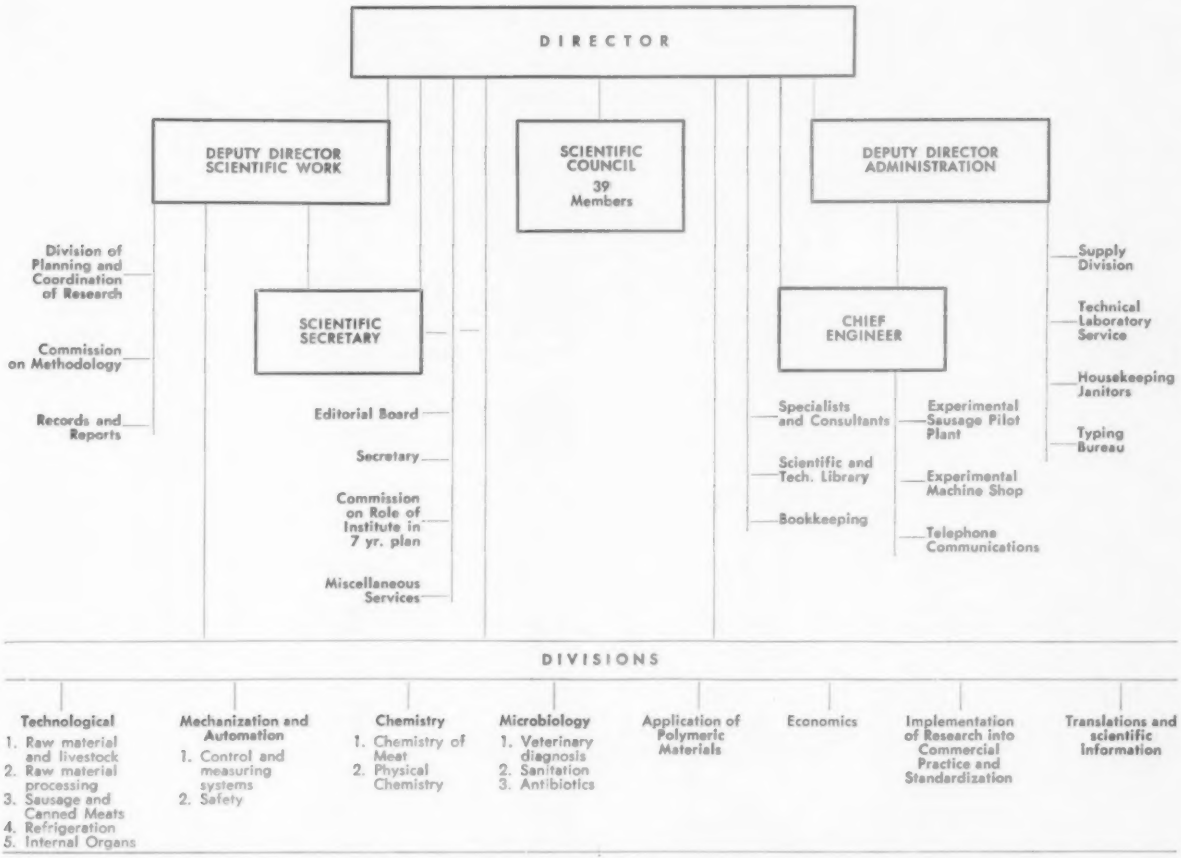


Fig. 2. Plan of organization of the All-Union Scientific Research Institute for the Meat Industry.

groups, pilot plants, and even small commercial plants. Their laboratories are not all well equipped, and some of their personnel are not as well qualified as they might be. Yet some of their equipment and scientists are top-flight, as we have seen at the All-Union Scientific Research Institute for the Meat Industry in Moscow, the Central Scientific Research Institute of the Bread Baking Industry, and the Scientific Research Institute of Food Industry of the Moldavian S.S.R. in Kishinev. They have large and extremely well equipped machine shops, where 20–25% of the total personnel of the research institute is employed. In these shops they not only can build what may be developed within the institute itself but also can copy machines purchased anywhere in the world or can build machines from drawings obtained elsewhere. Although these institutes can and do develop new ideas and techniques of their own, it is fair to say that emphasis is definitely on applying to the solution of Soviet food problems information from any source whatsoever. Food is the first need, and efficiency is second. Furthermore, patent and property rights on information are not recognized.

Each research institute has a committee on programs and policy, composed not only of the senior scientific officers of the institute but of key personnel from industry, agriculture, the Ministries of Trade and Health, and senior scientists from other institutes and universities. Fig. 2 shows the organization of the All-Union Scientific Research Institute for the Meat Industry, and Table 5 gives the breakdown of personnel for this Institute.

Planning institutes

A unique type of institute in the U.S.S.R. is the planning institute; so, a few words about one. The Central Institute of Planning for the Dairy Industry in Moscow is primarily a group of engineers, architects and draftsmen—550 in all—whose job is dairy plant design. Because of the critical shortage of architects and engineers this group makes standard layouts for any type of dairy plant—fluid milk, yogurt, ice cream, cheese, dry milk, dry-milk reconstituting plants, etc.—even earthquake-proof plants. These designs are supposed to be usable in any economic region. If the Sovnarkhoz (economic council) of the Kazakh "republic" wants to plant to produce kumys, which is fermented mare's milk, they can probably find one in the catalog of this Planning Institute of the Dairy Industry.

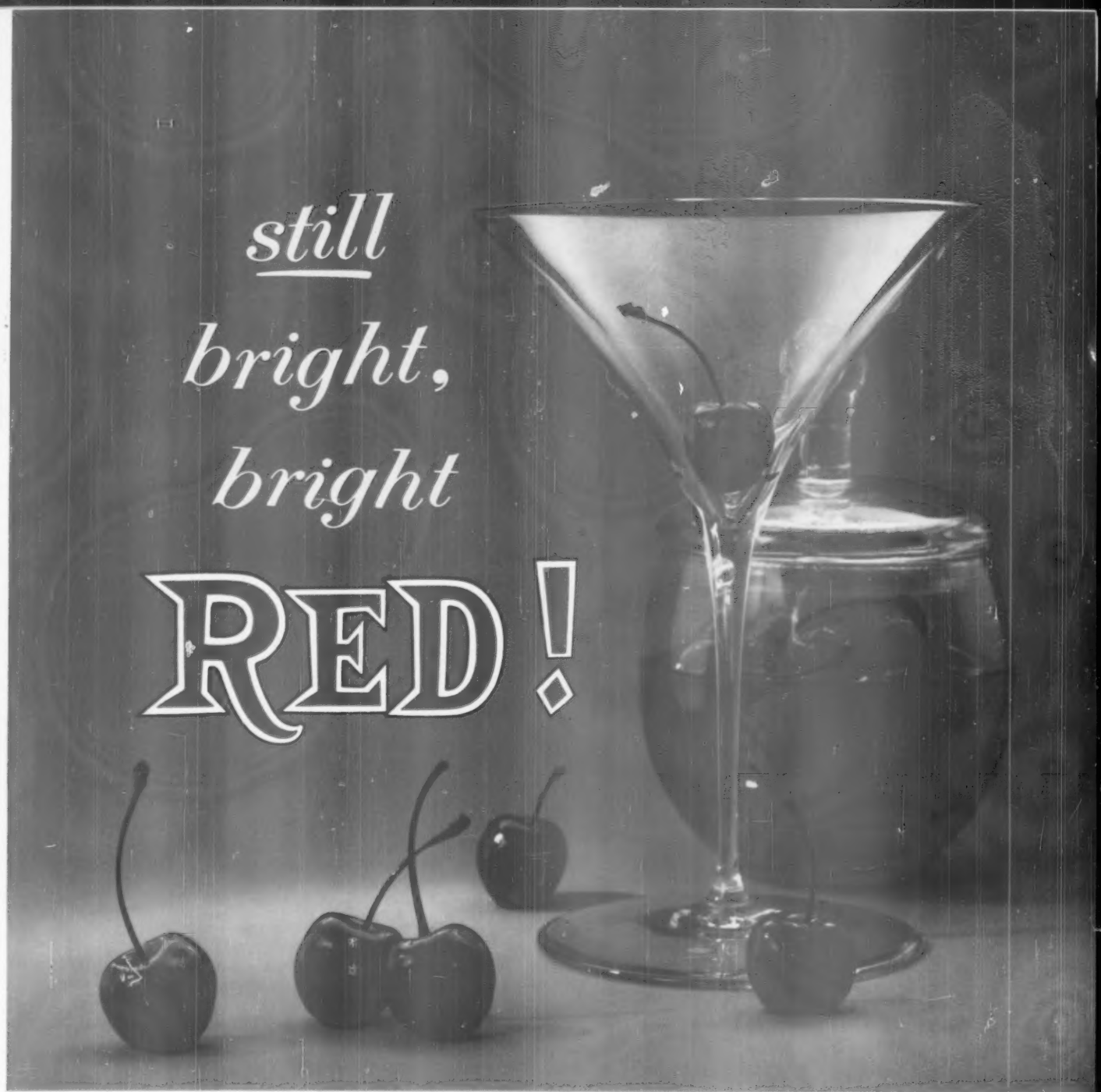
The program of the planning institute typifies the scarcity of highly trained personnel and the tight central control exerted in some areas. The standard layout or standard processing unit is emphasized so

that the same equipment is used throughout an industry as far as possible. If production must go up in a particular locality, multiple units must be installed. For example, the units designed for freezing fish at sea are the same as may be used in freezing meat or vegetables. (In Moscow, certain large buildings are reproduced many times to make the most efficient use of architects and construction engineers.) Such an approach occasionally leads to inefficient layouts, and sometimes even inadequate solutions to local production problems. When our group commented to this effect, it was pointed out that the need for food must take precedence over the efficiency or economy of a particular food-processing operation.

Food-processing plants

In addition to Moscow the group visited Kiev, Odessa, Kherson in the Ukraine; Baku in Aserbaidzam; and Alma Ata in Khazakhstan at the northern base of the Himalayas. Besides educational, research, and planning institutes, we visited several farms, canneries, meat-packing plants, bakeries, dairies, wineries, and even cognac and tea plants. One is impressed by the almost complete spectrum from the modern to the archaic. In some meat plants one is impressed by the mechanical skinning, streamlined boning operations, and efficient sausage production layouts, and yet other operations may be characterized by excessive use of hand labor. However, it must be remembered that labor is cheap. Some baking and milling operations are very good, with excellent new developments on continuous mixing and baking, and yet you might find this alongside hand bagging and weighing of flour; in one canning plant you may even see hand pitting of cherries or many very small individually operated open kettles for making jam, and in another plant ultramodern automatic tomato paste lines using equipment of Hungarian manufacture. One of the most striking comparisons was one plant using fairly modern equipment to produce 500 cans per minute with a crew of about 20 people, and another plant with about 50 people hand-making cans at a rate of about 70 per minute. Labor is plentiful, and by American standards most plants are inefficient. Mr. Robert MacLellan estimates that Russians use in their canneries eight times the labor and three times the floor space per unit of production that we do. This, of course, represents inefficient use of capital as well as labor. Rather poor workmanship was evident in much of the new construction, and this of course represents to some degree inefficient use of capital and continuing high maintenance costs. Even so, the Russian food processing plant is expected to turn over to the state a net profit of at least 8%. At the distribution level another 8% is expected. By contrast, American food industries are traditionally low-profit industries.

One other aspect of these industrial operations or combines should be mentioned—the welfare operations. Housing of workers may well be the responsibility of the combine, as well as nurseries for newborn babies of working mothers and rest homes



Maraschino cherries today blaze with the same full red color that is as traditional to them as black is to licorice or green to spearmint. In a particular way, this symbolizes the remarkable accomplishments that have been made to maintain the appetizing appeal and accustomed colors of foods.

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for the aged and infirm; vacation facilities, etc. The paternalism of the state is much in evidence in these activities. Yet, with such control, efficient use of the high-quality scarce foods for young children is possible.

Farms

The size and complexity of the farms puts a premium on efficient and proper management. There is still much improvement possible, and the filtering down from above of the scientific know-how of agricultural production is slow in an essentially uneducated rural population. To appreciate the problem, reflect on the figures given by the director of one of their best farms [Sovkhoz "Luch Vostoka" (Ray of the East) in Alma-Ata]. In 1959 the farm took in $4,100,000 ($3,500,000 from farm operations and $600,000 from a cinema and gaming hall), and the cost of operations was $2,600,000; net profit to the state, $1,500,000. There are 3000 workers representing 21 nationalities, and, with their families, more than 8000 people live on the farm. The average worker gets $55 per month.

Stalin Canning Plant as seen from its boat slip on the Dnieper at Kherson, Ukrainian S.S.R.

Table 5. Brief inventories of two state farms in the U.S.S.R.

State Farm in the Name of Lenin, Khotov Village, Kievo-Svyatoshensk Region, Ukrainian S.S.R.			
Total area (acres)			15,800
Crops			
(Wheat 1500, oats 625, buckwheat 150, corn 250, potatoes 1125, lucerne, 1250, misc. 1000)			7,900
Vegetables			700
Grapes			85
Berries			125
Pastures and meadows			3,125
Woodland			600
Farmer plots (0.40–1.50 acres/family)			1,875
Ponds			175
Population: 1900 families; average family 4½ persons. Families live in 8 villages.			
Water: 1 shallow well/5 families.			
Livestock		Equipment	
Cattle	2200 includes 700 milking cows	Tractors	27
Pigs	2000 includes 150 sows	Trucks	33
Hens	3000	Passenger cars	3
Geese	1500	Combines	4
Ducks	50,000 (by 1965)	Silage harvesters	6
Horses	312	Corn pickers	2
Wages			
Drivers, mechanics, cattle handlers			$120–150/month
Common labor			40– 50/month
Garden rent			36 acre/year
Ray of East State Farm, Alma-Ata, Kazakh C.S.R.			
Farm resulted by combining 1800 individual farms in 1929			
Total area (acres)			232,000
For grazing	202,500		
Cultivation	29,500		
Grain (wheat, barley, oats, etc.)			17,100
Vegetables			1,000
Potatoes			500
Lucerne			4,100
Corn			250
Berries			150
Grapes			350
Fruit (apples, pears, cherries)			1,000
Melons			300
Beets for feeding			300
"Rest," out of cultivation			4,450
Livestock		Equipment	
44,000 sheep		73 tractors	
3,300 cattle (950 milking cows)		65 trucks	
2,300 pigs		33 combines	
60,000 poultry		5 greenhouses	
1,100 horses (for herding sheep)		1 canning plant (1000 tons annual capacity)	
210 camels			
345 foxes		1 hatchery	
500 hives of bees		1 winery	
Size of family garden: 0.4 acre			

Table 6 gives additional data on the above-mentioned farm and on another of their very best farms, in the Ukraine. Whereas a few farms are efficiently operated, others are not. Agricultural products are sometimes badly handled after harvest, and this is, of course, just as bad as the failure to produce good crops in the first place. However, it is necessary to keep in mind that climate is very much against the Russian farmer in most areas. There is no secret of the fact that Russian agricultural production is not keeping pace, but this does not mean that increased food production is not possible. It is; but the sociological problems are of equal, or perhaps greater, importance than scientific problems of finding how to provide Russians with more and better food.

Marketing

There are no supermarkets as we know them. There are a few peasant markets, but these are of little consequence. The shops are under the Ministry of Trade, and each one usually sells only certain types of items.

Table 6. Personnel for the All-Union Scientific Research Institute for the Meat Industry.

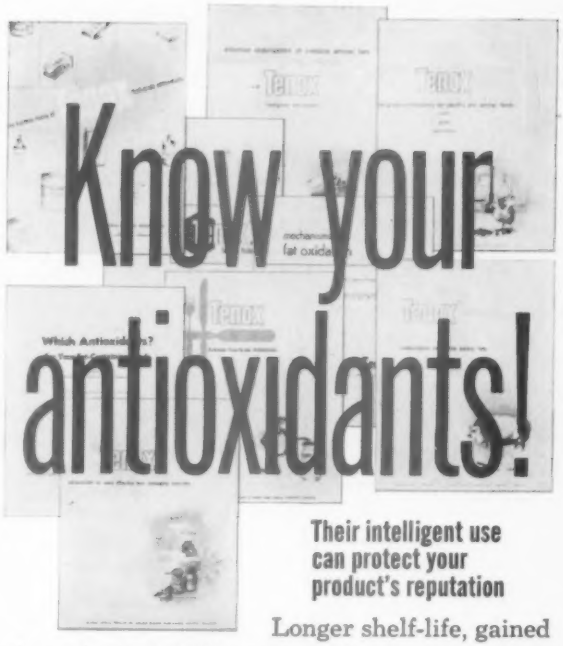
Administration		23
Senior Staff		68
D.Sc. and professors, including 1 Academician	4	
Candidates (equivalent to Ph.D.)	64	
Supporting staff		138
Technologists	53	
Animal husbandmen	5	
Biologists	21	
Chemists	6	
Economists and linguists	32	
Skilled labor	21	
Pilot plant		18
Machine shop		69
Personnel at branch institute in the Kazakh Republic		24
Total personnel		340

Because there are shortages the Russians must stand in line almost daily, for food buying is a daily rather than weekly chore, as in the U.S.A. There is absolutely no salesmanship or advertising, and this is most disconcerting to an American. In GUM'S (General Universal Magazine, Russia's most famous store, on Red Square), the customer chooses the food item he wishes to purchase, takes a check to the cashier for payment, and returns to surrender his receipt and pick up his purchase. Packaging material, which has become characteristic of the American food industry, is scarcely used.

Popular education of the people

Some of the food problems of the U.S.S.R. have been portrayed in a rather sketchy manner. Reference has also been made to the high cost of clothing as well as of food, and to critical housing conditions in the cities and poor living conditions in the rural areas. The total population has been classified into the ruling class (Communist party), the educated bourgeois, and the workers. Whereas the Poles, Hungarians, and millions of other eastern Europeans have known freedom and a better life, and resent the lowering of their standard of living, the Russians are improving their standard of living and many are better off than their parents and grandparents. They can see it and feel it. The controlled press and radio never lets them forget it, and prevents ready comparison with the outside world. The ordinary Russian is interested and curious about America, but not particularly hostile. This seems to be true in spite of the vitriolic and sometimes emotional anti-Americanism of the Soviet press and radio. There are clean streets; beautiful parks; the ballet; circus; music and the theatre, which are superb; broad avenues and large and attractive buildings, which help take the edge off of poor food, poor housing, no cars or consumer goods, etc. Billboards, press, and radio continually remind that the Russian economy is improving. The theme is: we (the Russians) are *here* today, but we will be *there* in 1965. This was heard in every research institute, educational institution, plant, and farm visited. It is seen

Tea blending and packing plant in Tbilisi, Georgian S.S.R.



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- **Which antioxidants for your fat-containing foods?**
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Tenox Eastman food-grade antioxidants

in parks, etc. The comparisons were made on food, housing, consumer goods, wages, hours of work, etc., etc.

The most effective presentation of this theme is at the permanent All-Union Exhibition of the Accomplishments of the People's Economy. This was started as an exhibition of agriculture, but it now includes all phases of the Soviet economy. Each "republic" has its building, and each major industry has one or more buildings, with agriculture (particularly food) playing a dominant part. There is a meat building, one for dairy, one for grain, where a Russian can buy a bowl of cornflakes with milk as part of the promotional campaign for corn; there are plots of fruit trees, corn, wheat, barley, etc. Many buildings have models of industrial plants or working models of machines. All give information on production now and in 1965. The exhibition, which is much like a world's fair, has the purpose of building pride in the Russian way, of repeating that the state is really looking out for the people, and of giving in one place the portrayal of what makes Russia tick economically. Perhaps it would not be out of place to suggest that we in the United States have such a national exhibition on a grand manner, where Americans and visitors from abroad could go and see a portrayal of the United States on the theme of national pride and purpose. What of a permanent exhibition to show the American way of life? How steel is made, or glass, or rayon, or paper. A model oil refinery, cement plant, farm plots. What the vote of a free man means. How banks, stock markets, and insurance companies work, and for what purpose. Where better could the American food industry portray to its own consumers and to the world just how and why our food is the world's cleanest and most wholesome food?

In summary

The foregoing remarks and descriptions of the U.S.S.R. food problems and how the Russians are trying to solve them should not be construed to mean that better things cannot be ahead for the Russians. Their situation can be improved. The accomplishments of our universities and experiment stations, government laboratories, and industrial groups are being studied for ways of accomplishing a Russian miracle analogous to the American food and agricultural miracle. The Russian food scientists and technologists are making notable contributions. We can learn much from these men as they develop solutions to problems arising from situations of food supply and distribution that are unique in the world. They can make much rapid progress in developing a modern, efficient food industry. Yet the sociological problems, which are less subject to such direct solution and which must be solved in order to get more basic food production, present formidable barriers to complete solution of this major problem in the U.S.S.R.—a plentiful supply of high-quality nutritious food for all its people. ●

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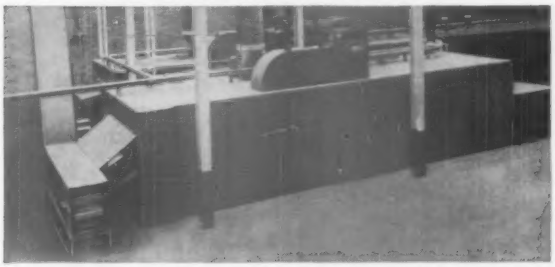

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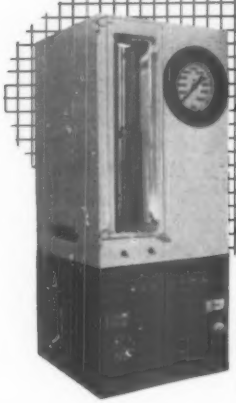

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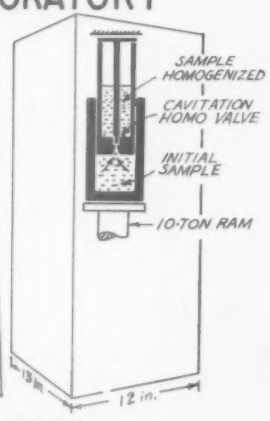

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Standards Development Program at the Bureau of Commercial Fisheries Technological Laboratory, Gloucester, Massachusetts

Anthony J. Frascatore,
Joseph H. Carver,
John J. Ryan, and
Richard D. Tenney [a]

THE PRIMARY PURPOSES of the standards program of the Bureau of Commercial Fisheries are to upgrade the quality of fishery products and to promote their orderly and efficient marketing. Quality is upgraded by furnishing to the producer a blueprint from which he can make the highest-quality product possible. Orderly and efficient marketing is achieved by furnishing to the distributor, wholesaler, and retailer an accurate description of the quality level of the product marketed. The consumer, the final judge of all products, is assured of obtaining products of known high quality.

The Bureau of Commercial Fisheries' first standards for grades were developed for frozen fried fish sticks by the then East Boston Technological Laboratory. The standard for this product was promulgated in 1956 and was adopted by many sections of the industry. Application of this standard was instrumental in reversing a downward trend in the national sales of fish sticks. Realizing the value of this first standard, the industry, through its associations, such as the National Fisheries Institute, requested the Bureau to develop standards for other products.

Since 1956, nine such standards have been developed in the Bureau's laboratories in Gloucester, Massachusetts; Seattle, Washington; College Park, Maryland; and Pascagoula, Mississippi. The Gloucester laboratory has developed standards for frozen haddock, cod and ocean-perch fillets, frozen fish blocks, and frozen raw breaded portions. Other Bureau laboratories have developed standards for frozen halibut and salmon steaks and raw breaded and raw headless shrimp.

The purpose of this paper is to discuss the following topics: The U. S. Department of the Interior Inspection and Certification Service, new concepts in standards development, factors considered in standards development, steps in development of a standard, and the current standards program.

Inspection and certification service

The U. S. Department of the Interior Inspection and Certification Service is the primary applier of the promulgated standards, and accordingly plays an important role in the program of standards development. This service unit, which is available to all commercial dealers of fishery products, works closely with standards-development personnel in the final preparation of a standard.

The inspectors in the unit not only examine fishery products for which standards are in effect but, on request, examine other fishery products and certify as to the condition of the products and as to the degree to which the purchaser's specifications are met. In 1958, when this service was started, there were 16 plants under continuous inspection. Today, there are 39 plants under continuous inspection and 6 lot-inspection offices across the country.

In plants under continuous inspection, all raw materials entering into the manufacture of the product are examined as well as the finished product itself. Finished products, after being examined for compliance with the applicable standard, are assigned a U. S. quality grade, which the producer is permitted to display on his package and in his advertising. Since all plants under inspection are required to maintain high standards of sanitation, the in-plant inspector performs another important function by inspecting the plant for sanitary conditions. The inspector thus acts both as a quality-control agent and as a sanitarian for the plant.

Lot inspection service is offered to those who wish to have inspected fishery products that have not undergone some prior official inspection. The products are inspected for condition and for compliance with grade standards or specifications as set forth by the purchaser. These products are not permitted to bear a grade seal, since the sanitary and manufacturing conditions under which the product was made are not known. The inspector certifies the product for compliance with the requirements for which the product was inspected. A certificate is issued giving the exact findings of the inspector.

The quantity of fishery products inspected has increased rapidly. In 1959, 110 million pounds were examined. In 1960, this quantity rose to 161 million pounds—an increase of 37% in one year (Fig. 1).

New concepts in standards development

As a result of the increasing number of standards available, inspection problems have multiplied in those plants producing diversified products. The older standards are complex and are time consuming and sometimes place severe demands upon an in-

[a] All Chemists, Bureau of Commercial Fisheries, Technological Laboratory, Emerson Avenue, Gloucester, Massachusetts.

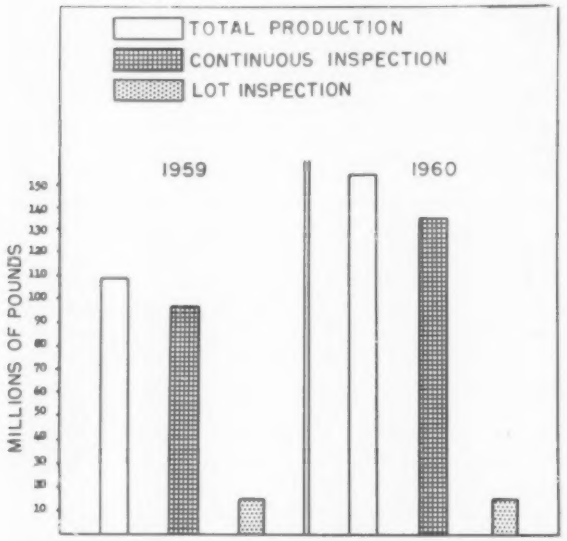

Fig. 1. 1959–60 production under U. S. Department of the Interior continuous-inspection program.

spector called to grade two or more products at one time. As experience is being gained in the design of standards, the time required to apply the standard is being reduced. For example, 45 minutes are required to grade one sample of fish sticks in accordance with the standard promulgated in 1956; whereas with a similar product, raw breaded portions, less than 30 minutes are required to ascertain the grade in accordance with the recently published standard for this product. Thus, as each individual standard is developed, every effort is made to streamline it to allow the inspector to grade a greater number of diversified products per shift and still act as a quality-control and sanitary inspector.

Despite the requirement for speed of inspection, the standard must retain its objectivity and be accurately descriptive of the best possible product available under commercial conditions. As a result, the standards are being designed in such a manner as to maintain objectivity while requiring minimum grading time. Techniques of statistical analysis are being applied more frequently to determine the exact significance of all factors considered within the standard. New equipment is being devised to make the measurements less tedious and to improve their accuracy. Objective criteria are being investigated for color and texture assessments to reduce the errors involved in the subjective evaluation of these factors.

Factors considered in standards development

In general, the main factors considered in the development of standards are as follows:

1) *Total appearance.* This factor includes, but is not limited to, the over-all appearance of the package, color of the product, and any dehydration of the product.

2) *Uniformity.* This factor includes the size, shape, and weight of the individual pieces within the package.

3) *Defects.* This factor generally includes natural blemishes, bones, and defects in cutting.

4) *Character.* This factor refers directly to the texture of the product.

5) *Organoleptic qualities.* This factor refers directly to flavor and odor. Any adverse organoleptic qualities limit the maximum attainable grade.

The relative importance of the above factors varies from standard to standard because of the variation in the characteristics in each type of product. In addition, there are other factors that are peculiar to an individual product. An example of this aspect is the presence of shell fragments on occasion in prepared shellfish products.

The various factors are carefully assessed as to their magnitude, frequency, and relative effect on quality. After they have been assessed, a scoring system is devised that realistically describes the quality level of the product.

Steps in development of a standard

The eight basic steps required in the actual development of a standard are as follows:

1) Industry requests a specific standard, and the over-all need for the standard is determined by the Bureau of Commercial Fisheries.

2) A plan is devised to obtain samples that statistically represent current production.

3) All defects in the commercially produced product are classified.

4) The defects are statistically evaluated to rank their effect on over-all quality.

5) A provisional draft of the standard is prepared.

6) The provisional standard is tested under actual plant conditions to determine its efficiency and workability.

7) Joint Industry-Bureau meetings are held to discuss the provisional standard.

8) The standard is promulgated in the *Federal Register*.

As indicated in the foregoing steps, a request by industry, stating need for a standard for a particular product, must first be received. The request usually comes from the National Fisheries Institute, which acts as a liaison agent between industry and government. The request is then carefully analyzed to establish that a need for the standard really exists. The request must represent the thinking of a large part of the industry, and the product must be in substantial commercial production. If these requirements are met, the Bureau then authorizes development of a standard for the product. Industry is contacted, and samples are obtained on a statistical basis, using the latest available production figures. Samples are obtained from both wholesale and retail outlets. The sampling rate is at the 94% confidence level and is prorated in accordance with an individual plant's output in relation to the national production. While the product is being sampled, individual views on what is needed in the standard are gathered from

Vitamin A man

It may well be that Bob Edwards, our general sales manager, has called on you. He is selling the output of the plant that makes *Myvax® Vitamin A Acetate* and *Palmitate*, and *Myvax Dry Vitamin A Palmitate*.

To keep the plant busy, Mr. Edwards grinds out the mileage like an airline pilot. Or a ubiquitous service representative. Which, in essence, he is. For, in this business, successful selling does not revolve about the shine on your shoes or even the force of your personality. You sell, ultimately, by what you can do to help your customer.

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producers and distributors. All samples are evaluated as soon after procurement as possible. If storage prior to evaluation is required, the samples are held at −20°F. All samples are evaluated for the incidence of quality defects, whether natural or manufacturing in origin. The magnitude, frequency, and over-all effect of defects on quality are noted.

The defects are then classified, and each is statistically analyzed for its significance. Generally, only defects more than one standard deviation from the normal in both frequency and magnitude are considered detrimental to quality. Using the results of the statistical analysis, the Bureau designs score sheets, which are commented on by industry at informal cuttings and in-plant testing. The score sheets and comments form the basis on which a provisional draft of the standard is prepared. The requirements set forth in the standard reflect the product of highest quality that processors can economically produce. The product is precisely described so as to include all its styles, types, and varieties.

Major producers test the workability of the provisional standard under actual production and comment on whether it is realistic and a true measure of quality. Comments received are carefully considered in the editing of the provisional draft. Public hearings are held and are attended by members of industry and government. Purchasing agents, brokers, distributors, packers, and members of consumer organizations also are invited. Comments at the hearings are evaluated and are reflected in the final draft of the provisional standard.

The provisional standard is promulgated in the *Federal Register* as a Notice of Proposed Rule Making. A period of 30 additional days is allowed for industry comment prior to final publication of the standard in the *Federal Register* as a Notice of Rule Making. Once published, the standard becomes official.

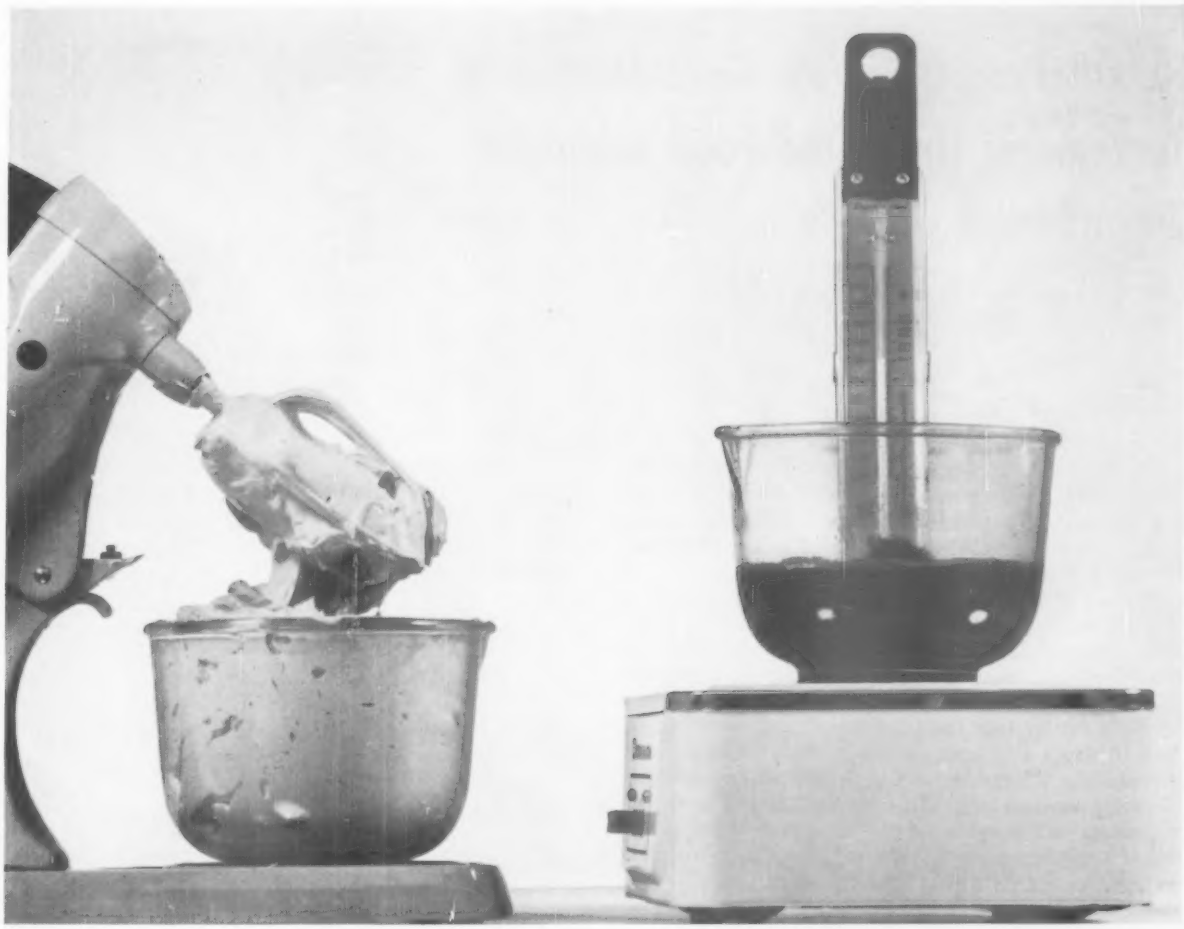
Current program

At present, the Gloucester laboratory is developing new standards for frozen fried breaded portions, fried scallops, and pollock fillets. The laboratory is cooperating with the Bureau's Seattle laboratory in developing a standard for frozen flounder and sole fillets and is revising the fish-stock standard to reflect modern industry practices. In the future, standards will be developed for frozen whiting, frozen fried fillets, frozen raw scallops, and for other important fishery products. It is expected that the development of standards for such species of fish as pollock and whiting will help to further improve the quality and marketability of these species.

REFERENCES

Southerland, F. L., and Elinor T. Linderer. 1946. Questions and Answers on Government Inspection of Processed Fruits and Vegetables, Misc. Pub. No. 598 U.S.D.A., Production and Marketing Administration, Washington 25, D. C., 26 pp.

Spangler, Raymond L. 1946. Standardization and Inspection of Fresh Fruits and Vegetables, Misc. Pub. No. 604, U.S.D.A., Production and Marketing Administration, Washington 25, D. C., 28 pp. ●



To foam or not to foam?

We can help you either way

If you are interested in the miraculous new "fruit-fluffs" or "frozen fruit-fluffs," read this:

The bowl on the left contains grape juice in the form of a "fruit-fluff." It has about 18 times as much volume as when we put the juice in the bowl and beat it. All it took was a small amount of either of those types of *Myverol*® distilled monoglycerides which we make from hydrogenated lard or hydrogenated cottonseed oil, plus whipping.

We could have put a trace of the same material with the grape juice, or with any other fruit juice or puree, and whipped it while freezing. The result would have been a "frozen fruit-fluff" that looks familiar, tastes wonderful, and is low in calories.

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The bowl on the right contains more of the same grape juice boiling without the usual troublesome foaming because we added a small amount of another type of *Myverol* distilled monoglycerides we make from an unsaturated vegetable oil.

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Recent Progress in the Consideration of Flavoring Ingredients Under the Food Additives Amendment. II.*

Richard L. Hall
McCormick & Company, Inc., Baltimore 2, Maryland
and
Bernard L. Oser
Food and Drug Research Laboratories Incorporated, Maspeth 78, New York

THIS PAPER, the third in a series (Hall, 1959, 1960), reviews activities carried out during the past year under the aegis of the Food Additives Committee of the Flavoring Extract Manufacturers' Association (FEMA).

The FEMA began work under the Food Additives Amendment by submitting, at the request of the Food and Drug Administration, a tentative listing of flavoring substances that served as the basis for the first FDA White List on natural flavors. Next, we began a survey that included practically every major manufacturer and many users of food and beverage flavors. By this means, we gathered a large mass of reliable data on the identity, levels, volumes, importance, and manner of use of flavor ingredients. Some toxicological information also came from the survey.

When it became apparent we could not analyze and apply the results of the survey in time to meet the March 5, 1960, deadline, we applied for a one-year extension on all substances not yet on a proposed White List.

In later discussions with the FDA, different views were expressed as to the best way of establishing the status of many flavoring ingredients under the Amendment. This matter, having been analyzed in detail in the last paper, is not repeated here. It is sufficient to say that we decided not to file petitions for regulations governing a large group of flavoring ingredients which were excluded by statutory definition because no question of safety existed, or for which it would clearly be impossible to satisfy the regulatory requirements for a petition. We chose instead to submit all available information to a panel of independent and fully qualified experts who would have complete freedom to decide which ingredients were, and which were not, generally recognized as safe (GRAS) under conditions of intended use. This panel has been organized and is functioning. At the end of this paper appears a list of all flavor ingredients now considered GRAS by the panel. It includes the earlier list published (*Food Processing*, 1961; *What's New in Food and Drug Research*, 1961; *Food Chemical News*, 1961), and supersedes the tentative list in the prior paper (Hall, 1960).

In accordance with the previously announced program, we are about to solicit the firms that participated in our survey to determine the extent to which they are willing to finance the testing necessary on substances whose status has not yet been resolved by the panel.

Future activities will include: a) the testing program itself; b) continuing to supply to FDA full and final information on our survey and the results of the expert panel evaluations in each instance; and c) publication of the detailed results of our program in monograph form.

The remainder of this paper concerns the organization and operation of the expert panel, the criteria employed in arriving at its judgments, and the results obtained.

We early decided on a panel of six to eight experts. Fewer would make it difficult to obtain an adequate breadth of representation of areas of special interest; more would introduce problems of communication and full attendance, as well as expense.

Among the areas of special competence included in the backgrounds of our panel members are biochemistry and intermediary metabolism, toxicology and metabolism of hydrocarbons, correlation of chemical structure and pharmacology of drugs, physiologic distribution and metabolism of food components, carcinogenesis, and cancer chemotherapeutic drugs. The panel includes members with academic, industrial, governmental, and independent institutional experience. Some have served on special food additive committees of the National Research Council and various scientific organizations, both national and international. Some have served on expert advisory committees for the FDA, and one is a former member of its scientific staff. In serving on this panel, the members have acted in their individual capacities, and in no way have they represented the organizations with which they are affiliated. Their names and addresses are:

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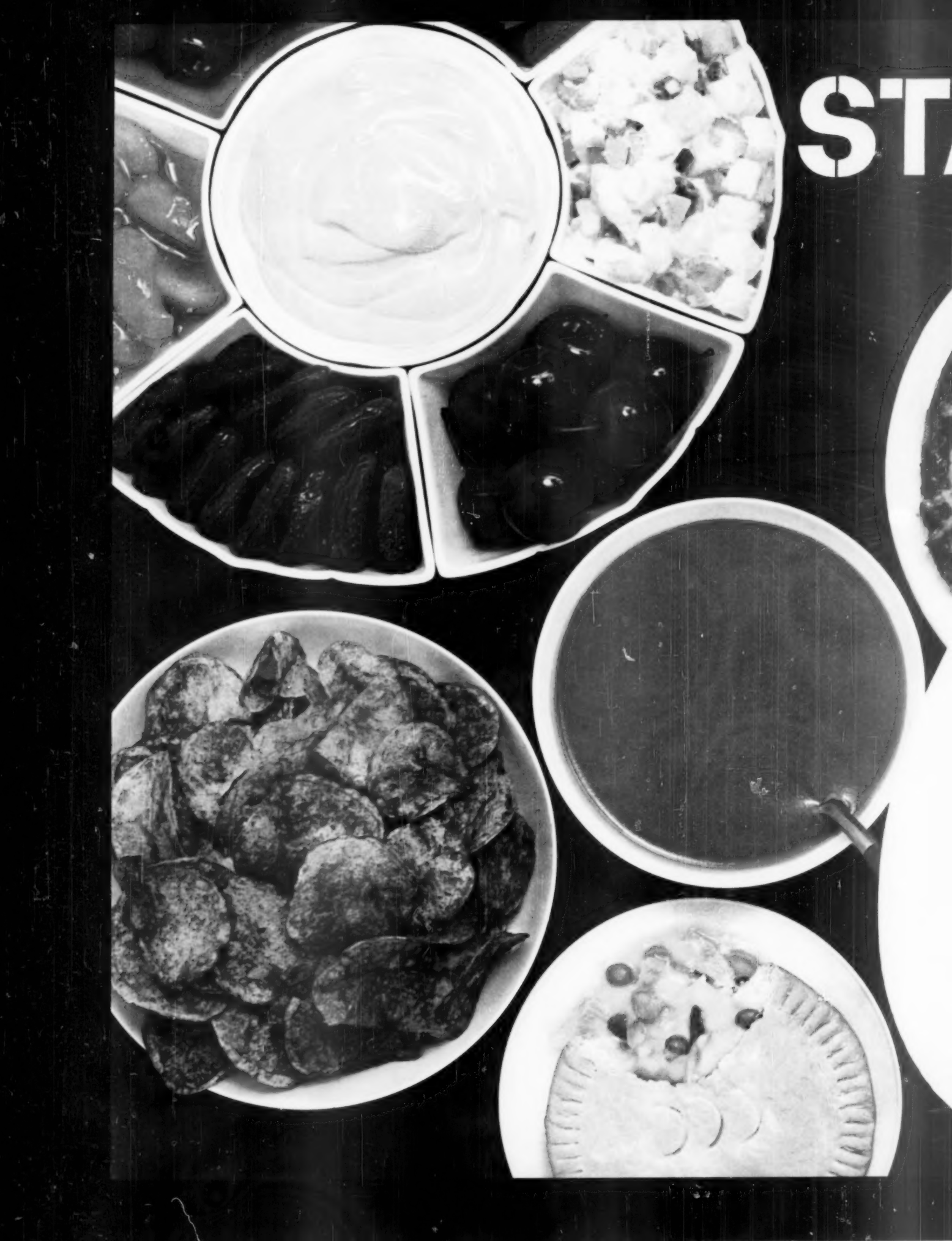
(Continued on page 22)

* Presented at the Twenty-first Annual Meeting, Institute of Food Technologists, New York.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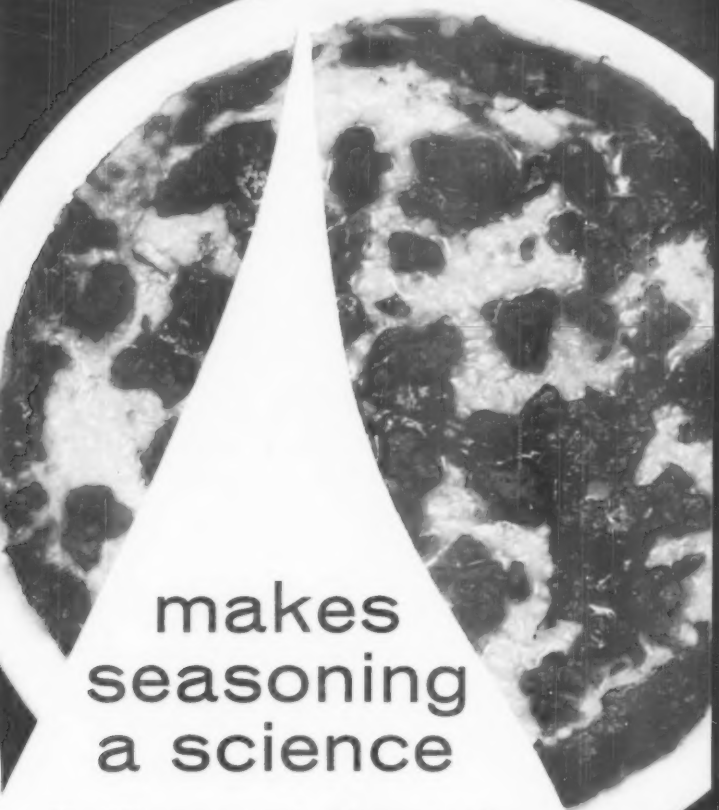

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The ability to create and produce a seasoning to meet your exact needs, plus the assurance that it is in compliance with Food Additive Laws—*IS A SCIENCE AT STANGE.*

The ability and versatility to produce seasonings such as Soluble, Liquid, 50-A Microground® and Ground for all types of finished products *IS A SCIENCE AT STANGE.*

The technical skill to control the flavor potency of each and every shipment to precise specifications—*IS A SCIENCE AT STANGE.*

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50-A Microground Spice® NDGA Antioxidant® Ground Spice
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SPICE IS SPICE ...BUT

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One of the authors (B.L.O.), as the FEMA'S consultant on food additive matters, organized the panel. Both authors participated in the deliberations of the panel.

It is of interest that the scientific publications of this group in the fields of toxicology, pharmacology, and related areas, total more than 400.

The panel's first step was to consider the substances involved in terms of chemical groupings into which they fall, the information available, and the types of decisions required.

Recognition of groups of related compounds that could, with due caution, be considered together, and among which useful analogies could be made, was an early phase in the panel's evaluation. There is ample precedent, both scientific and legal,[b] for such grouping.

As the panel gained familiarity, it began to develop tentative criteria, and upon these criteria arrived at preliminary conclusions.

A noteworthy aspect of the panel's operation was the frequent and stimulating cross-flow of ideas. It rapidly became apparent that the panel collectively was far more informed than any of its members individually. Clearly, no amount of separate study, and no independent individual opinions could replace the common judgment achieved in open meeting. Face-to-face discussion was absolutely essential. Each determination by the panel that a substance is GRAS under conditions of intended use represents the unanimous conclusion of the panel.

The panel has assumed from the beginning that the identity of the ingredient in question conforms to that implicit in its name. There will be cases in which specifications are necessary to assure the exclusion of undesirable impurities. This is also true of many substances now on White Lists for which the only practical guide at present is "appropriate food grade," or "good manufacturing practice." The panel's conclusions regarding safety concern only the ingredient named.

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[b] " . . . In determining, . . . whether a proposed use of a food additive is safe, the Secretary shall consider among other relevant factors . . . the cumulative effect of such additive . . . taking into account any chemically or pharmacologically related substance or substances . . . " [Food Additives Amendment of 1958, Sec. 409(c)(5).]

"Food additives that cause similar or related pharmacological effects will be regarded as a class, . . . " [Food Additive Regulations, Subpart A, Section 121.4 (a).]

Several factors have been of key importance in the reasoning by which the panel has arrived at a decision as to the status of each substance. Among these are:

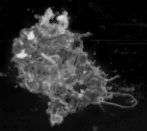
(1) Toxicity data;
(2) Metabolic data;
(3) Occurrence of the substance in natural foods;
(4) Analogies with chemically related substances, the toxicity or metabolism of which is known;
(5) The nature, level, and volume of use of the substance in foods; and
(6) The toxicologic significance of the levels in use.

Toxicity data, where available, provided the most useful information. In a number of cases, this information from short-term animal studies was available through the courtesy of manufacturers who sponsored such tests of flavor components several years ago. In other instances, short-term or acute information was available because of present or intended uses other than as flavors. In a few cases, information from chronic studies was at hand, but seldom were these designed in relation to intended use of the substance as a flavor.

In the course of its work, the panel found that a considerable amount of information existed on the metabolism of flavor ingredients. These data were not only to be found in authoritative reference books such as that by Williams (1959), but were frequently buried in the literature, often collected in the course of work on other substances and for other reasons. It should be emphasized that, in judging safety, it is not enough merely to say that the metabolic fate of a substance is known. It is important to consider not only the original substance but its metabolites, and the organism's capacity to detoxify and eliminate them. The panel recognizes the inherent limitations of any single criterion. It is particularly aware of our lack of full knowledge of biotransformations and their resulting physiological effects. Nevertheless, it found the existing information on such biotransformations exceedingly helpful, particularly in view of the very low levels of use of these substances compared with the levels at which the biochemical and pharmacological studies were originally conducted. Metabolic data, and assumptions based on such data, played a part in the panel's decisions more frequently than any other type of experimental information.

The panel attached appropriate weight to the occurrence of a substance in natural foods. The more widely the substance has been found, the higher the levels (where known), and the greater the volume of consumption of the foods involved, the stronger the presumption of safety that can be drawn.

Probably the most difficult area of decision involved analogies as to toxicity and metabolic fate based on similarities in chemical structure. The panel has frequently based its conclusions, at least in part, on such analogies, and in a few cases entirely on analogy. Many factors affect the validity of such reasoning. Clearly, if there is considerable information on sev-



eral members of a tentative grouping and this information indicates consistency of behavior within the group, then the strength of further analogies is greatly enhanced. For example, the body's ability to split simple esters or to metabolize safely straight-chain fatty acids and alcohols, is well established. There are other groups of compounds about the safety of which a great deal is known. The members of such groups constitute the great majority of flavoring ingredients.

Naturally, all such information must be interpreted in the light of intended use in human food. Levels of use, total volume consumed, and type of foods involved are among the major factors that permit a knowledge or estimate of toxicity to be converted into an estimate of safety or hazard. The judgment of the panel that a substance is GRAS applies only to uses under the conditions and within the limits established in the FEMA survey. These limits will be specified in a forthcoming monograph. Until this appears, good manufacturing practice can continue to be a reasonable guide.

The very low levels and volumes of use of most flavoring substances raise the general question of the toxicological significance of the substances at these levels. Our expert panel believes that flavor ingredients used at average maximum levels of less than 10 ppm in foods, and at an annual volume of less than 1,000 pounds, for at least 10 years of common use, can indeed be said to be toxicologically insignificant under conditions of intended use, provided the chemical structure is compatible with a reasonable presumption of the capacity of the body to dispose of trace quantities safely through known metabolic pathways.

The panel recognizes that most flavor ingredients are quantitatively self-limiting, so that excessive use would render food inedible.

It should be clear from this that in only a few cases does the panel base its conclusions on clear-cut and exhaustive studies in which each compound stands alone. Instead, the picture is more complex. The amount of information available on any group of closely related compounds is considerable. But it may consist of acute and short-term studies on one member, acute data on two others, metabolic studies on one or more of the group, and the knowledge that several of the ingredients have been found in natural foods.

The unanimous scientific judgment of the panel determines to what extent the information and inferences thus available can be extended to other members of the series. Stated differently, the judgment of the panel determines the size and composition of the group of ingredients within which consistent relationships can reasonably be assumed to obtain.

After the panel finishes its detailed consideration of each substance, it periodically reviews its actions to date, in order to eliminate errors, ensure consistency, and refine the criteria employed.

To date (July, 1961), the panel has completed its evaluation of more than 800 substances. At this point, 662 are GRAS, and 130 will be held for further study. One hundred and nineteen (119) will be subject to no further action by the FEMA Food Additives Committee and expert panel, because of lack of interest or information. There are an additional 463 natural spices, seasonings, essential oils, etc., on which the panel has decided not to pass judgment.

The criteria the panel has employed on pure chemical substances are not applicable to mixtures of uncertain composition, such as essential oils and botanicals. In formulating its White Lists, the FDA has available to it not only the basis of common use, but also other provisions of the Food, Drug and Cosmetic Act[c] that the panel has considered to be outside the area of scientific judgment, and hence chose not to employ.

In its work, the panel has studied more than 1,000 Keysort summary sheets, and repeatedly reviewed these, comparing similar compounds. It has spent more than 100 hours in meetings, excluding travel, correspondence, and considerable individual study.

The testing program was discussed in the previous paper in this series. *In vitro* tests are planned in addition to metabolic and feeding studies in animals, depending on the individual compound or class within which it falls. The principal classes on which additional information is needed are acetals, lactones, alkynoic esters, epoxy acid esters, and certain ethers, ionone derivatives, and coumarin derivatives. The FEMA has applied for an additional extension, under the regulations recently announced, for all these substances on which our work may continue. If the necessary testing is not sponsored cooperatively by industry, the substances involved will probably disappear from use as the extensions expire, unless some company or companies independently choose to support further study. As the testing of compounds, or groups of compounds, is completed, we shall publish the results, and resubmit these new findings to the expert panel for final evaluation of general recognition of safety based on all the data then available.

The FEMA is satisfied that the measures described here fulfill both the spirit and letter of the law. After our experience with the expert panel, we doubt that it would be practical, or even possible, to assemble a more competent and effective group, or to obtain more informed and valid judgments. So far as general recognition of safety under the conditions of intended use is concerned, the panel's conclusions stand unless questioned by equally competent authority armed with controverting evidence. While we do not require or ask further action by any other group, we welcome

[c] Sec. 402. "A food shall be deemed to be adulterated—(a) (1) If it bears or contains any poisonous or deleterious substance which may render it injurious to health; *but in case the substance is not an added substance*, such food shall not be considered adulterated under this clause if the quantity of such substance in food does not ordinarily render it injurious to health; . . . " (emphasis supplied)—Federal Food, Drug and Cosmetic Act.

FDA concurrence in these conclusions. To that end, the FEMA is making available to the FDA the full background of information on each item, as quickly as it can be put in suitable form, and is seeking as wide publication and as much familiarity with its actions as is possible.

We expect that food firms will find the published lists of the FEMA expert panel useful in the same way as White Lists are used, in assuring themselves and their customers of compliance with the provisions of the law. We welcome opportunities such as this to review our work and expose it to the comments and criticism of others.

REFERENCES

Food Chemical News, February 27, 1961.

Food Processing, March, 1961, page 27.

What's New In Food and Drug Research, April, 1961.

Hall, Richard L. 1959. Flavoring agents as food additives. *Food Technol.*, **13**, 14.

Hall, Richard L. 1960. Recent progress in the consideration of flavoring ingredients under the food additives amendment. *Food Technol.* **14**, 488.

Williams, R. T. 1959. *Detoxication Mechanisms*. 2d ed. John Wiley & Sons, New York.

FLAVORING EXTRACT MANUFACTURERS' ASSOCIATION

Flavoring Substances Generally Recognized as Safe for Their Intended Use

Acetaldehyde
Acetic acid
Acetic acid, *iso*-amyl ester
Acetic acid, anisyl ester
Acetic acid, benzyl ester
Acetic acid, bornyl ester
Acetic acid, *iso*-bornyl ester
Acetic acid, butyl ester
Acetic acid, *iso*-butyl ester
Acetic acid, calcium salt
Acetic acid, carvyl ester
Acetic acid, cinnamyl ester
Acetic acid, citronellyl ester
Acetic acid, cyclohexanethyl ester
Acetic acid, cyclohexyl ester
Acetic acid, decyl ester
Acetic acid, dihydrocarvyl ester
Acetic acid, α,α-dimethylphenethyl ester
Acetic acid, dodecyl ester (Lauryl acetate)
Acetic acid, 2-ethyl butyl ester
Acetic acid, ethyl ester
Acetic acid, eugenyl ester
Acetic acid, *iso*-eugenyl ester
Acetic acid, furfuryl ester
Acetic acid, geranyl ester
Acetic acid, heptyl ester
Acetic acid, 2-hexenyl ester
Acetic acid, hexyl ester
Acetic acid, 1-hydroxy-3-nonanone ester
Acetic acid, isopropyl ester
Acetic acid, linalyl ester
Acetic acid, menthyl ester
Acetic acid, α-methylbenzyl ester
Acetic acid, methyl ester
Acetic acid, 2-methyl-4-phenyl-2-butyl ester
Acetic acid, neryl ester
Acetic acid, 1,3-nonanediol mixed esters
Acetic acid, nonyl ester
Acetic acid, octyl ester
Acetic acid, phenethyl ester
Acetic acid, 4-phenyl-2-butanol ester
Acetic acid, phenylpropyl ester
Acetic acid, piperonyl ester
Acetic acid, potassium salt
Acetic acid, propyl ester
Acetic acid, *iso*-pulegol ester
Acetic acid, rhodinyl ester
Acetic acid, santalyl ester
Acetic acid, sodium salt
Acetic acid, terpinyl ester
Acetic acid, tetrahydrofurfuryl ester
Acetic acid, *o*-tolyl ester
Acetic acid, *p*-tolyl ester
Acetic acid, 10-undecene-1-ol ester
Acetic acid, vanillin ester
(tri-)Acetin
Acetoacetic acid, benzyl ester
Acetoacetic acid, butyl ester
Acetoacetic acid, *iso*-butyl ester
Acetoacetic acid, ethyl ester
Acetoacetic acid, geranyl ester
Acetoin
Acetophenone
Acetylcitric acid, tributyl ester
2-Acetyl-3-phenylpropionic acid, ethyl ester
Aconitic acid
Aconitic acid, mixed ethyl esters
Acrylic acid, ethyl ester
Adipic acid
Alginates, sodium, calcium and ammonium
Allyl isothiocyanate
4-Allylveratrole (Eugenyl methyl ether)
Amyl alcohol
iso-Amyl alcohol
Anethole
Angelic acid, *iso*-butyl ester
Anisaldehyde
Anisic acid, ethyl ester
Anisic acid, methyl ester
Anisole
Anisyl alcohol
Anthranilic acid, allyl ester
Anthranilic acid, butyl ester
Anthranilic acid, *iso*-butyl ester
Anthranilic acid, cinnamyl ester
Anthranilic acid, cyclohexyl ester
Anthranilic acid, ethyl ester
Anthranilic acid, linalyl ester
Anthranilic acid, methyl ester
Anthranilic acid, phenethyl ester
Anthranilic acid, terpinyl ester
Ascorbic acid
Benzaldehyde
Benzoic acid
Benzoic acid, *iso*-amyl ester
Benzoic acid, benzyl ester
Benzoic acid, *iso*-butyl ester
Benzoic acid, ethyl ester
Benzoic acid, eugenyl ester
Benzoic acid, geranyl ester
Benzoic acid, isopropyl ester
Benzoic acid, linalyl ester
Benzoic acid, methyl ester
Benzoic acid, phenethyl ester
Benzoic acid, propyl ester
Benzoic acid, sodium salt
Benzoin
Benzophenone
Benzoylacetic acid, ethyl ester
Benzyl alcohol
3-Benzyl-4-heptanone
Borneol
iso-Borneol
Brominated vegetable oils
1-Butanol
2-Butanone
Butter acids[a]
Butter, esters[b]
iso-Butyl alcohol
Butylated hydroxyanisole (BHA)
Butylated hydroxytoluene (BHT)
α-*iso*-Butylphenethyl alcohol
p-tert-Butylphenylacetic acid, methyl ester
Butyraldehyde
iso-Butyraldehyde
Butyric acid
iso-Butyric acid
Butyric acid, allyl ester
Butyric acid, amyl ester
Butyric acid, *iso*-amyl ester
Butyric acid, anisyl ester
Butyric acid, benzyl ester
iso-Butyric acid, benzyl ester
Butyric acid, butyl ester
Butyric acid, *iso*-butyl ester
iso-Butyric acid, butyl ester
iso-Butyric acid, *iso*-butyl ester
Butyric acid, cinnamyl ester
iso-Butyric acid, cinnamyl ester
Butyric acid, citronellyl ester
iso-Butyric acid, citronellyl ester
Butyric acid, cyclohexyl ester
Butyric acid, decyl ester
iso-Butyric acid, α,α-dimethylbenzyl ester
Butyric acid, α,α-dimethylphenethyl ester
Butyric acid, α-ethylbenzyl ester
Butyric acid, ethyl ester
iso-Butyric acid, ethyl ester
Butyric acid, geranyl ester
iso-Butyric acid, geranyl ester
Butyric acid, heptyl ester
iso-Butyric acid, heptyl ester
Butyric acid, hexyl ester
Butyric acid, isopropyl ester
iso-Butyric acid, isopropyl ester
Butyric acid, linalyl ester
iso-Butyric acid, linalyl ester
Butyric acid, α-methylbenzyl ester
Butyric acid, methyl ester
iso-Butyric acid, methyl ester
iso-Butyric acid, 2-methyl-4-phenyl-2-butanol ester
Butyric acid, 2-methyl-2-propen-1-ol ester
Butyric acid, neryl ester
iso-Butyric acid, neryl ester
Butyric acid, octyl ester
iso-Butyric acid, octyl ester
Butyric acid, phenethyl ester
iso-Butyric acid, phenethyl ester
iso-Butyric acid, 2-phenoxyethyl ester
Butyric acid, 2-phenylpropyl ester
iso-Butyric acid, 3-phenylpropyl ester
iso-Butyric acid, piperonyl ester
Butyric acid, propyl ester
iso-Butyric acid, propyl ester
Butyric acid, rhodinyl ester
iso-Butyric acid, rhodinyl ester

[a] Assuming that these are a mixture consisting only of the saponified acids reported in the literature as derived from butter in the approximate proportions normally occurring.

[b] Assuming that these are the ethyl esters of butter acids (q.v.).

Butyric acid, terpinyl ester
iso-Butyric acid, terpinyl ester
Butyric acid, tetrahydrofurfuryl ester
iso-Butyric acid, p-tolyl ester
(tri-)Butyrin
Butyryllactic acid, butyl ester
Caffeine
Camphene
d-Camphor
Caramel color
Carboxymethylcellulose
Carvacrol
Carveol
4-Carvomenthenol
Carvone
β-Caryophyllene
Cinnamaldehyde
Cinnamic acid
Cinnamic acid, allyl ester
Cinnamic acid, *iso*-amyl ester
Cinnamic acid, benzyl ester
Cinnamic acid, butyl ester
Cinnamic acid, *iso*-butyl ester
Cinnamic acid, cinnamyl ester
Cinnamic acid, cyclohexyl ester
Cinnamic acid, ethyl ester
Cinnamic acid, heptyl ester
Cinnamic acid, isopropyl ester
Cinnamic acid, linalyl ester
Cinnamic acid, methyl ester
Cinnamic acid, phenethyl ester
Cinnamic acid, 3-phenylpropyl ester
Cinnamic acid, propyl ester
Cinnamic acid, terpinyl ester
Cinnamyl alcohol
Citral
Citric acid
Citric acid, sodium salt
Citric acid, triethyl ester
Citronellal
d-Citronellol
l-Citronellol
Citronellyloxyacetaldehyde
p-Cresol
Crotonic acid, allyl ester
Cuminaldehyde
Cyclohexaneacetic acid
Cyclohexaneacetic acid, allyl ester
Cyclohexanebutyric acid, allyl ester
Cyclohexanehexanoic acid, allyl ester
Cyclohexanepropionic acid, allyl ester
Cyclohexanepropionic acid, ethyl ester
Cyclohexanevaleric acid, allyl ester
p-Cymene
δ-Decalactone
Decanal
Decanoic acid
Decanoic acid, ethyl ester
1-Decanol
2-Decen-1-al
2-Decenoic acid, butyl ester
Diacetyl
Diallyl disulfide
Diallyl sulfide
Dibutyl sulfide
Dihydrocarveol
p-Dimethoxybenzene
2,4-Dimethyl acetophenone
2,3-Dimethylcrotonic acid, benzyl ester
2,6-Dimethyl-5-heptenal
2,6-Dimethyl octanal
3,7-Dimethyl-1-octanol
α,α-Dimethylphenethyl alcohol
Dimethyl sulfide
1,3-Diphenyl-2-propanone
δ-Dodecalactone
Dodecanal (Lauraldehyde)
Dodecanoic acid (Lauric acid)
Dodecanoic acid, *iso*-amyl ester (*iso*-Amyl laurate)
Dodecanoic acid, butyl ester (Butyl laurate)
Dodecanoic acid, ethyl ester (Ethyl laurate)
Dodecanoic acid, methyl ester (Methyl laurate)
Dodecanoic acid, *p*-tolyl ester (*p*-Cresyl laurate)
1-Dodecanol (Lauryl alcohol)
2-Dodecenal
Draco rubin, extract
Erythorbic acid (*iso*-Ascorbic acid)
Estragole (*p*-Allylanisole)
Ethanol
6-Ethoxy-*m*-anol (Propenyl guaethol)
p-Ethoxy benzaldehyde
2-Ethoxy-*p*-cymene (Carvacryl ethyl ether)
2-Ethoxy-5-propenylanisole (*iso*-Eugenyl ethyl ether)
2-Ethylbutyraldehyde
2-Ethylbutyric acid
2-Ethylbutyric acid, allyl ester
Ethylene oxide[c]
4-Ethylguaiacol
2-Ethyl-2-heptenal
Ethyl nitrite
Ethyl vanillin
Eucalyptol
Eugenol
iso-Eugenol
Farnesol
d-Fenchone
Fenchyl alcohol
Formic acid
Formic acid, amyl ester
Formic acid, *iso*-amyl ester
Formic acid, anisyl ester
Formic acid, benzyl ester
Formic acid, bornyl ester
Formic acid, *iso*-bornyl ester
Formic acid, butyl ester
Formic acid, *iso*-butyl ester
Formic acid, cinnamyl ester
Formic acid, citronellyl ester
Formic acid, cyclohexyl ester
Formic acid, α,α-dimethylphenethyl ester
Formic acid, ethyl ester
Formic acid, eugenyl ester
Formic acid, *iso*-eugenyl ester
Formic acid, geranyl ester
Formic acid, heptyl ester
Formic acid, hexyl ester
Formic acid, isopropyl ester
Formic acid, linalyl ester
Formic acid, α-methylbenzyl ester
Formic acid, neryl ester
Formic acid, octyl ester
Formic acid, phenethyl ester
Formic acid, 3-phenylpropyl ester
Formic acid, propyl ester
Formic acid, rhodinyl ester
Formic acid, terpinyl ester
Fumaric acid
2-Furanacrylic acid, propyl ester
2-Furanbutyric acid, *iso*-amyl ester
2-Furanmethanethiol (Furfuryl mercaptan)
2-Furanpropionic acid, *iso*-amyl ester
2-Furanproprionic acid, *iso*-butyl ester
2-Furanpropionic acid, ethyl ester
Furfural
Furfuryl alcohol
Furoic acid, allyl ester
Furoic acid, amyl ester
Furoic acid, hexyl ester
Furoic acid, methyl ester
Furoic acid, phenethyl ester
Furoic acid, propyl ester
Furyl acrolein
1-Furyl-2-propanone
Fusel, oil, refined[d]
Gallic acid, propyl ester (Propyl gallate)
Geraniol
Glucose pentaacetate
Glycerol
Glycyrrhizin, ammoniated
Guaiac gum, extract
Guaiacol
Guar, gum
Heptanal
2,3-Heptanedione
Heptanoic acid, allyl ester
Heptanoic acid, amyl ester
Heptanoic acid, butyl ester
Heptanoic acid, *iso*-butyl ester
Heptanoic acid, ethyl ester
Heptanoic acid, methyl ester
Heptanoic acid, octyl ester
Heptanoic acid, propyl ester
1-Heptanol
2-Heptanone
3-Heptanone
4-Heptanone
Hexadecanoic acid (Palmitic acid)
Hexadecanoic acid, ethyl ester (Ethyl palmitate)
1-Hexadecanol (Cetyl alcohol)
Hexanal
2,3-Hexanedione
Hexanoic acid
Hexanoic acid, allyl ester
Hexanoic acid, amyl ester
Hexanoic acid, *iso*-amyl ester
Hexanoic acid, butyl ester
Hexanoic acid, *iso*-butyl ester
Hexanoic acid, ethyl ester
Hexanoic acid, geranyl ester
Hexanoic acid, hexyl ester
Hexanoic acid, isopropyl ester
Hexanoic acid, linalyl ester
Hexanoic acid, methyl ester
Hexanoic acid, 3-phenylpropyl ester
Hexanoic acid, propyl ester
1-Hexanol
2-Hexenal
2-Hexenoic acid, methyl ester
2-Hexen-1-ol
3-Hexen-1-ol
p-Hydroxybenzoic acid, butyl ester
p-Hydroxybenzoic acid, methyl ester
p-Hydroxybenzoic acid, propyl ester
Hydroxycitronellal
Hydroxycitronellol
3-Hydroxy-2-methyl-γ-pyrone (Maltol)
5-Hydroxy-4-octanone
4-(*p*-Hydroxyphenyl)-2-butanone
Indole
p-Isopropyl acetophenone
Isopropyl alcohol
p-Isopropylbenzyl alcohol
3-(*p*-Isopropyl)phenyl propionaldehyde
Lactic acid
Lactic acid, butyl ester
Lactic acid, ethyl ester
Levulinic acid
Levulinic acid, butyl ester
Levulinic acid, ethyl ester
d-Limonene
Linaloöl
1-Malic acid
Malic acid, diethyl ester
1,8-*p*-Menthadien-7-ol
Menthol
(d)-neo-Menthol
Menthone
Methanethiol (Methyl mercaptan)
β-Methiopropionaldehyde (Methional)
β-Methiopropionic acid, methyl ester
4′-Methoxyacetophenone
2-Methoxy-4-methyl phenol
4-(*p*-Methoxyphenyl)-2-butanone
1-*p*-Methoxyphenyl-2-propanone
2-Methoxy-4-vinyl phenol
p-Methyl acetophenone
o-Methylanisole
p-Methylanisole
α-Methylbenzyl alcohol
2-Methylbutyraldehyde
3-Methylbutyraldehyde
Methyl cellulose
α-Methyleinnamaldehyde
3-Methylcyclopentane-1,2-dione
5-Methylfurfural
2-Methylheptanoic acid
6-Methyl-5-hepten-2-one
2-Methyl-3-(*p*-isopropylphenyl) butanal

[c] As a fumigant for whole and ground spices, provided that residues of ethylene oxide do not exceed 50 ppm.

[d] Assuming that refined fusel oil is mixed amyl alcohols, predominantly 3-Methyl-1-butanol.

2-Methyloctanal
4-Methyl-2,3-pentanedione
2-Methylpentanoic acid
4-Methylpentanoic acid, methyl ester
4-Methyl-2-pentanone
β-Methylphenethyl alcohol (Hydratropyl alcohol)
p-Methylphenylacetaldehyde
3-Methyl-2-phenylbutyraldehyde
5-Methyl-1-phenyl-2-pentanone
Monosodium glutamate
Myrcene
Nerol
Nerolidol
2,6-Nonadienol
Nonanal
Nonanoic acid
Nonanoic acid, allyl ester
Nonanoic acid, *iso*-amyl ester
Nonanoic acid, ethyl ester
Nonanoic acid, methyl ester
1-Nonanol
2-Nonanone
2-Nonenoic acid, methyl ester
Octadecanoic acid
Octadecanoic acid, butyl ester
Octadecanoic acid, glyceryl monoester
Octadecanoic acid, propylene glycol monoester
Octanal
Octanoic acid
Octanoic acid, allyl ester
Octanoic acid, amyl ester
Octanoic acid, *iso*-amyl ester
Octanoic acid, ethyl ester
Octanoic acid, heptyl ester
Octanoic acid, hexyl ester
Octanoic acid, linalyl ester
Octanoic acid, methyl ester
Octanoic acid, nonyl ester
Octanoic acid, octyl ester
1-Octanol
2-Octanol
3-Octanol
2-Octanone
3-Octanone
3-Octanon-1-ol
Oleic acid
Oleic acid, ethyl ester
Oleic acid, glyceryl monoester
Pentanal
2,3-Pentanedione
2-Pentanone
4-Pentenoic acid
α-Phellandrene
Phenethyl alcohol
Phenoxyacetic acid
Phenoxyacetic acid, allyl ester
Phenylacetaldehyde
Phenylacetic acid
Phenylacetic acid, allyl ester
Phenylacetic acid, *iso*-amyl ester
Phenylacetic acid, benzyl ester
Phenylacetic acid, butyl ester
Phenylacetic acid, *iso*-butyl ester
Phenylacetic acid, cinnamyl ester
Phenylacetic acid, citronellyl ester
Phenylacetic acid, ethyl ester
Phenylacetic acid, *iso*-eugenyl ester
Phenylacetic acid, geranyl ester
Phenylacetic acid, guaiacyl ester
Phenylacetic acid, isopropyl ester
Phenylacetic acid, methyl ester
Phenylacetic acid, octyl ester
Phenylacetic acid, phenethyl ester
Phenylacetic acid, propyl ester
Phenylacetic acid, rhodinyl ester
Phenylacetic acid, santalyl ester
Phenylacetic acid, *p*-tolyl ester
4-Phenyl-2-butanol
4-Phenyl-3-buten-2-ol
4-Phenylbutyric acid, ethyl ester
4-Phenylbutyric acid, methyl ester
1-Phenyl-3-methyl-3-pentanol
1-Phenyl-1-propanol
3-Phenyl-1-propanol
2-Phenylpropionaldehyde (Hydratropaldehyde)
3-Phenylpropionaldehyde
3-Phenylpropionic acid
3-Phenylpropionic acid, ethyl ester
3-Phenylpropionic acid, methyl ester
o-Phosphoric acid
o-Phosphoric acid, disodium salt
o-Phosphoric acid, tricalcium salt
α-Pinene
β-Pinene
Piperidine
Piperine
d-Piperitone
Piperonal
Polyoxyethylene (20) sorbitan monolaurate (Tween 20)
Polyoxyethylene (20) sorbitan monooleate (Tween 80)
Polyoxyethylene (20) sorbitan monostearate (Tween 60)
1-Propanol
2-Propene-1-thiol (Allyl mercaptan)
4-Propenylveratrole (*iso*-Eugenyl methyl ether)
Propionaldehyde
Propionic acid
Propionic acid, allyl ester
Propionic acid, *iso*-amyl ester
Propionic acid, anisyl ester
Propionic acid, benzyl ester
Propionic acid, *iso*-bornyl ester
Propionic acid, butyl ester
Propionic acid, *iso*-butyl ester
Propionic acid, carvyl ester
Propionic acid, cinnamyl ester
Propionic acid, citronellyl ester
Propionic acid, cyclohexyl ester
Propionic acid, decyl ester
Propionic acid, ethyl ester
Propionic acid, geranyl ester
Propionic acid, hexyl ester
Propionic acid, isopropyl ester
Propionic acid, linalyl ester
Propionic acid, α-methylbenzyl ester
Propionic acid, methyl ester
Propionic acid, neryl ester
Propionic acid, octyl ester
Propionic acid, phenethyl ester
Propionic acid, 3-phenylpropyl ester
Propionic acid, propyl ester
Propionic acid, rhodinyl ester
Propionic acid, terpinyl ester
Propionic acid, tetrahydrofurfuryl ester
p-Propyl anisole
Propylene glycol
Propylene glycol alginate
α-Propylphenethyl alcohol
iso-Pulegol
Pulegone
iso-Pulegone
Pyridine
Pyruvaldehyde
Pyruvic acid
Pyruvic acid, *iso*-amyl ester
Pyruvic acid, ethyl ester
Quinine bisulfate
Quinine hydrochloride
Quinine sulfate
iso-Quinoline
Rhodinol
Saccharine, sodium salt
Salicylaldehyde
Salicylic acid, *iso*-amyl ester
Salicylic acid, benzyl ester
Salicylic acid, *iso*-butyl ester
Salicylic acid, ethyl ester
Salicylic acid, methyl ester
Salicylic acid, phenethyl ester
Santalol
Sarsaparilla, extract*
Sebacic acid, dibutyl ester
Sebacic acid, diethyl ester
Skatole
Sodium hexametaphosphate
Sorbic acid, allyl ester
Sorbic acid, ethyl ester
Sorbic acid, potassium salt
Sorbitan monostearate (Span 60)
Sorbitol
Succinic acid, diethyl ester
Succinic acid, dimethyl ester
Sucrose octaacetate
Sulfur dioxide
Tannic acid
Tartaric acid
Tartaric acid, diethyl ester
α-Terpineol
Terpinolene
Tetradecanal (Myristaldehyde)
Tetradecanoic acid (Myristic acid)
Tetradecanoic acid, ethyl ester
Tetradecanoic acid, methyl ester
Tetrahydrofurfuryl alcohol
Tetrahydro-ψ-ionone
Tetrahydrolinalool
Thienyl thiol
Thymol
Tiglic acid, ethyl ester
Tiglic acid, phenethyl ester
p-Tolualdehyde
α-Toluenethiol (Benzyl mercaptan)
4-(*p*-Tolyl)-2-butanone
2-(*p*-Tolyl)propanal
2-Tridecenal
2,3-Undecadione
Undecanal
1-Undecanol
2-Undecanone
9-Undecenal
10-Undecenal
10-Undecenoic acid, allyl ester
10-Undecenoic acid, butyl ester
10-Undecylenic acid, ethyl ester
9-Undecylenic acid, methyl ester
Valeric acid
iso-Valeric acid
iso-Valeric acid, allyl ester
iso-Valeric acid, ammonium salt
iso-Valeric acid, *iso*-amyl ester
iso-Valeric acid, benzyl ester
Valeric acid, bornyl ester
iso-Valeric acid, bornyl ester
iso-Valeric acid, *iso*-bornyl ester
Valeric acid, butyl ester
iso-Valeric acid, butyl ester
iso-Valeric acid, cinnamyl ester
Valeric acid, citronellyl ester
iso-Valeric acid, cyclohexyl ester
Valeric acid, ethyl ester
iso-Valeric acid, ethyl ester
iso-Valeric acid, geranyl ester
iso-Valeric acid, isopropyl ester
iso-Valeric acid, linalyl ester
iso-Valeric acid, menthyl ester
Valeric acid, methyl ester
iso-Valeric acid, methyl ester
iso-Valeric acid, neryl ester
iso-Valeric acid, nonyl ester
iso-Valeric acid, octyl ester
iso-Valeric acid, phenethyl ester
iso-Valeric acid, 3-phenylpropyl ester
iso-Valeric acid, propyl ester
iso-Valeric acid, rhodinyl ester
iso-Valeric acid, terpinyl ester
Vanillin
Veratraldehyde (Vanillin methyl ether)
Yucca brevifolia, extract
Yucca mohavensis, extract
Zingerone

* Judged solely on the basis of common use.

New Food Research Laboratories for C.S.I.R.O. Australia

NEW LABORATORIES and facilities for the Division of Food Preservation of the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.) were officially opened September 18th by Dr. D. A. Cameron, Federal Minister for Health and for the C.S.I.R.O., before a large group representing Government, University Departments, and the Australian food industry. The new facilities occupy a 10-acre site at North Ryde, near Sydney.

A four-day food science conference followed the ceremonies, attended by 250 Australian food scientists and technologists. Overseas speakers included: E. C. Bate-Smith, Low Temperature Research Station, Cambridge, England; J. B. Biale and C. O. Chichester, University of California, U.S.A.; R. H. Locker, Meat Industry Research Institute, New Zealand; and H. Wilkinson, Unilever Food Research Laboratory, Sharnbrook, England. The proceedings of this Conference will be published in *Food Preservation Quarterly*, Vol. 21, No. 4, December, 1961.

Background of Food Research

The principal body engaged in food research in Australia is the Division of Food Preservation of C.S.I.R.O. C.S.I.R.O. is a statutory body established by the federal government and administered by an executive group of nine members, most of whom are scientists. It was set up to investigate scientific and technological problems influencing the prosperity and productivity of primary and secondary Australian industries. The activities of C.S.I.R.O. are organized in 44 divisions and sections. One of the larger of these divisions is the Division of Food Preservation.

C.S.I.R.O. entered the field of food research in the late 1920's. In 1932, a Section of Food Preservation and Transport was formed. Transport of food was specifically mentioned in the name of this Section because the first problems confronted were those concerned with the movement of foods over long distances by sea and by land. The shipment of chilled beef from Australia to the United Kingdom developed into a successful industry as a result of the Section's investigations on abattoir hygiene and gas storage. Another early investigation—on the transport and ripening of bananas—established procedures used ever since for bringing bananas at optimum ripeness from Queensland and New South Wales to consumers in the southern states.

The first laboratories of the section were located in the Brisbane Abattoir, Queensland. A branch laboratory is still maintained there. In 1938, the Section established its headquarters laboratory at the Homebush Abattoir, which serves the city of Sydney. In 1940, the Section was made a division of C.S.I.R.O.

During World War II, the division's resources were largely concentrated on problems of supplying food to the Armed Services and the United Kingdom. Australian firms were assisted in undertaking production of many food products not previously made in Australia—notably, items needed by U. S. forces in the South Pacific. This required the establishment of new research groups on canning, dehydration, and packaging. These have remained important aspects of the division's work. In the course of wartime activities, members of the division came into frequent contact with food technologists attached to the U. S. army. These associations developed many firm friendships.

After 20 years at Homebush, the Division had outgrown facilities there, and funds were made available for new laboratories. The Division is now comfortably and adequately housed in buildings that provide convincing evidence that the federal government recognizes the importance of food research in the economy of Australia.

The New Laboratories

The division's new laboratories stand on a pleasant, elevated site close to the Lane Cove National Park, and comprise 11 buildings having a total floor area of 71,000 sq ft. They are set in a landscaped campus (Fig. 1), and connected by covered footways that also carry some services overhead. Provision was made in planning for an over-all future expansion of about 50 percent, and the disposition of the buildings on the site was largely determined by the desire to ensure that extensions could be made without interference with normal functioning.

The Administration Building houses the chief of the division, the secretarial and clerical staffs, and the library. Closely adjoining is the E. W. Hicks Meeting Room, named in honor of the late physicist and mathematician, a pioneer member of the Division who served as acting chief on many occasions. In a central position are the taste-testing laboratory, carefully planned to provide a standard environment for sensory testing, the canteen, and the general service facilities.

The Canning, Packaging, Dried Foods, and Frozen Foods Sections occupy laboratories in the Food Technology Building, on the north side of the site. They also use the facilities in the adjoining Food-Processing Building. Here there is an open processing area of 130×50 ft (Fig. 2), together with ancillary facilities including a control laboratory, a workshop, and store-

Fig. 1. New C.S.I.R.O. Food Research Laboratories, North Ryde, Australia.

Fig. 2. Interior of the Food Processing Building. A pressure spin cooker is in the left foreground.

rooms. Experimental packs of most kinds of processed foods can be reproduced with the facilities and equipment provided. They include preparation lines for fruits, fruit juices, vegetables, and meats; vacuum and steam flow closing machines; a retort for canning and glass packing; atmospheric and pressure spin cookers; two tunnel dehydrators; and a blast freezer. In a separate building are a sulfuring room, for studies on the treatment of dried fruits with sulfur dioxide, and a chemical processing laboratory, for operations with volatile solvents.

On the south side of the site is the Food Science Building, which houses the Physics, Microbiology, and Chemistry Sections; Fresh Fruit and Vegetable Storage Section; and an Animal-Products Section, dealing with meat, fish, poultry, and eggs. Forming a wing to the Food Science Building is a block of 31 controlled-temperature rooms providing storage facilities at temperatures ranging from −20 to 120°F. Four of these rooms are gas-tight, for the storage of fruit in controlled atmospheres.

The two-story laboratory buildings are constructed of brick and reinforced concrete, with aluminum roofs. The window frames and removable spandrels are made of enamelled aluminum (Fig. 3). Sun penetration on the long north and south sides of the buildings is controlled by continuous concrete hoods and vertical precast concrete fins. All the services to the laboratories are placed in perimeter ducts, against the north and south walls, which are readily accessible through the external aluminum panels.

In layout, the individual laboratories fall generally into two types, serving the needs of either chemical or biological work. In addition, there is a considerable variety of service rooms. These include balance, instrument, fume and chromatography rooms, and a specially designed suite of preparation and sterilizing rooms for the microbiology section (Fig. 4).

Sharing the North Ryde site with the Division of Food Preservation is the Bread Research Institute of Australia, an organization financed jointly by the bread-baking industry and C.S.I.R.O. This institute, in turn, houses a C.S.I.R.O. Wheat Research Unit. There is thus a useful centralization of food-research establishments at North Ryde. Dairy products are the responsibility of a separate section of C.S.I.R.O., the Dairy Research Section, at Highett, in Victoria.

Staff and Finance

The Division of Food Preservation has a total staff of 150, including 43 graduate research officers, 35 graduate experimental officers, and 49 technical assistants. Of these, 107 are working at the North Ryde laboratories, together with nine visiting workers.

The division's annual budget exceeds 300,000 Australian pounds ($700,000), of which over 90 percent is provided by the federal treasury. The balance comes from contributions from other government departments and statutory bodies, and from a wide range of individual companies in the food and ancillary industries. The Australian food industry is being encouraged to take an increasing financial responsibility for research directed toward solving its own technical problems, either by direct support for C.S.I.R.O., by setting up research associations such as the Bread Research Institute, or by establishing research laboratories in individual firms.

Research Program

The field of investigation of the Division of Food Preservation may be defined as the handling, preservation, processing, storage, and transport of meats, fish, eggs, fruits, and vegetables. The division employs more than half its resources on fundamental research, seeking deeper understanding of the properties of foods and of the changes they undergo during processing and preservation. The current research program thus includes many projects in chemistry, biochemistry, physics, microbiology, and plant physiology, in addition to technological projects on the preservation of foods by canning, dehydration, and refrigeration.

Investigations in the Fresh Fruit and Vegetable Storage Section are related to important changes taking place in methods of packaging and transport of fruits and vegetables, including the use of bulk bins and changing from wooden cases to fiberboard

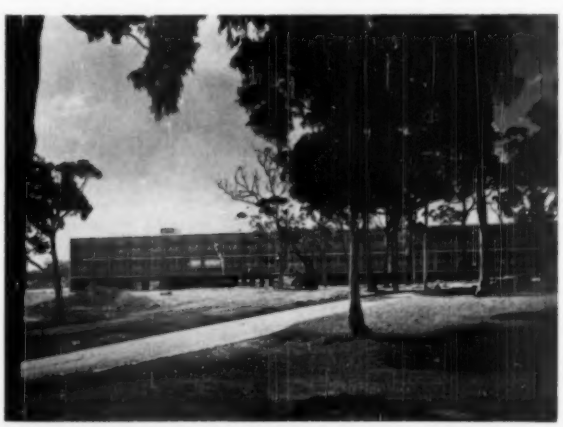


Fig. 3. The south side of the Food Science Building.

cartons. This section is also concerned with the control of mold wastage in citrus fruits, and the use of controlled atmospheres and polyethylene case liners to extend the storage life of apples and pears.

A broadly based study of the factors affecting the eating quality and appearance of meat is being conducted in the division's laboratories at Brisbane and North Ryde. This study embraces ante-mortem treatments of animals, and the effects of rigor mortis and freezing on the protein and other constituents of muscle. Worthwhile progress is being made in research on the nature and control of "freezer burn" on refrigerated meat products.

There are two major projects on eggs. One is concerned with the effects of constituents of the hen's diet on egg quality, and the other with the rates of deterioration of eggs during normal marketing operations from the farm to the consumer.

In the Canning Section, evaluation of safe processes for canned foods is a continuing responsibility. Particular interest has been taken in methods for accelerating the heat process by agitating the cans. Objective methods for the measurement of texture in foods are being developed and applied to problems in pea harvesting, pineapple canning, and apricot canning. Chemical studies on anthocyanin and other flavonoid pigments in foods have arisen from discoloration problems in canned berry fruits, pears, green beans, and onions.

Australian tinplate manufacturers are sponsoring a project on outstanding problems in the mechanism of tinplate corrosion. Packaging studies are being extended in order to accumulate information on the properties and uses of flexible plastic films, with particular reference to their use as containers for heat-processed foods.

Techniques of sulfuring fruit prior to drying are being studied in the Dried-Foods Section, together with problems in dehydrofreezing of peas and the drying and dehydrocanning of apples. The Frozen-Foods Section is occupied with elucidation of the nature and causes of the onset of off flavors in frozen fruits and vegetables during storage.

In the Chemistry Section, recent techniques of gas chromatography and infrared spectroscopy are being brought to bear on two kinds of problems associated with the volatile constituents of foods: volatiles that cause superficial scald in stored apples, and volatiles that are responsible for natural and foreign flavors in foods. Considerable progress has been made in studies of reaction mechanisms in the non-enzymic browning of foods and its control by sulfur dioxide.

The results of theoretical studies in the Physics Section on heat and mass transfer across laminar boundary layers will be applicable to many problems encountered by food technologists, such as the rate of loss of heat and moisture from meat during cooling. This section is also collecting data on some physical aspects of the freeze drying of foods.

Fundamental studies in microbiology are designed to give precise information on factors governing the growth and death of microorganisms that cause food spoilage and food poisoning. Specific projects are concerned with the effects of the water activity of the growth medium, and the nature of the inhibitory effects of carbon dioxide on many psychrophilic bacteria. Studies on the germination and growth of bacterial spores are particularly applicable to problems of spoilage in low-acid canned foods. Investigations in meat bacteriology are concerned with slaughter-floor hygiene, and the use of aerosols in disinfection of the air of chilling rooms.

Fig. 4. A corner of the Microbiological laboratories. Sterile glassware is placed in the cabinet from the preparation room and taken out from the corridor.

The organization of the plant cell and the factors controlling its uptake and use of nutrients are the general themes of the research program in plant physiology. Studies on the metabolism of carbohydrates and organic acids, and on the properties of plant cell membranes, are related to many problems in the preservation of fruits and vegetables.

The division has recently established a small group to work in collaboration with the Australian Atomic Energy Commission on possible applications of ionizing radiations in food preservation. Current work is concerned with control of insect infestation, e.g., fruit fly in citrus fruits, and control of mold growth on fruits, by moderate doses of radiation. Some basic studies are also being made on the influence of temperature, oxygen, and water availability on the effects of ionizing radiations on bacterial spores.

Branch Laboratories

In addition to the headquarters laboratory at North Ryde, the Division of Food Preservation carries out its research program in several branch laboratories. The Brisbane laboratory, already mentioned, has become the main center of meat research. It is particularly concerned with the studies on meat quality, and the problem of "drip" from frozen carcass meat. The Division joined with the New South Wales Department of Agriculture to set up a Citrus Wastage Research Laboratory at Gosford, N.S.W., for investigations on citrus fruit handling and preservation. Another branch laboratory was established in the C.S.I.R.O. Regional Laboratory at Hobart, to study some aspects of the preservation of fruits and vegetables peculiar to Tasmania. ●

HOW tac* CAN HELP USERS OF FOOD CHEMICALS

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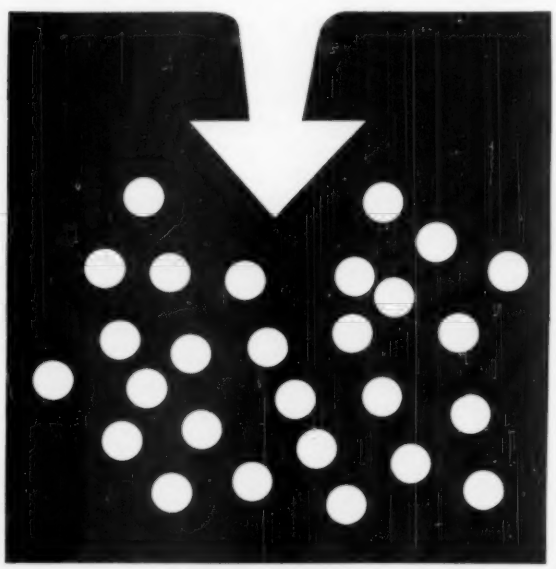

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Evaluation of Gentisic Acid and Sodium Gentisate as Food Antioxidants[a]

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(Manuscript received May 10, 1961)

SUMMARY

The effectiveness of gentisic acid (2,5-dihydroxybenzoic acid) and its sodium salt as antioxidants for several types of foods and inedible fats was investigated. In lard, cottonseed oil, fish oil, and grease, stability was judged by the active oxygen method, and carry-through stability was measured by the oxygen bomb technique. Storage stability of essential oils was determined by organoleptic, color, and peroxide evaluations. Stability of frozen frankfurters and frozen uncured bacon belly was evaluated by the thiobarbituric acid method. Results indicate that gentisic acid and sodium gentisate are potentially useful antioxidants for a variety of foods.

THE NEED for antioxidant protection in many foods and related products is well established. Relative effectiveness of a given antioxidant (or combination of antioxidants) characteristically varies among different classes of food products, as well as within each class. In some cases, adequate oxidative stability is not readily achieved with any of the existing food antioxidants. The antioxidative potency and physical properties of gentisic acid (2,5-dihydroxybenzoic acid) and sodium gentisate were therefore investigated, though neither compound has yet been approved for use in foods.

LITERATURE REVIEW

Early references to gentisic acid date back as far as 1850 (Beilstein, 1927). Subsequent interest in the compound and its sodium salt largely resulted from reports of possible therapeutic uses and from its occurrence as a metabolite of acetylsalicylic acid (aspirin).

The toxicity and metabolism of gentisic acid and sodium gentisate have been thoroughly investigated in a variety of animal species, and in man (Clarke and Mosher, 1953; Drill, 1958). Both compounds proved lower in toxicity than aspirin, and are excreted very rapidly and completely in the urine.

Little attention has been given to possible antioxidant applications for gentisic acid and sodium gentisate. Riemenschneider (1947) listed gentisic acid with a number of other phenolic compounds that he believed should be considered for use as antioxidants. Later, Morris and Riemenschneider (1949) reported on the antioxidant properties of a number of polyhydroxybenzoic acids, including gentisic acid. Their data on gentisic acid was inconclusive, but indicated that it was at least moderately effective as an antioxidant in lard.

EXPERIMENTAL METHODS

Fats and oils. Unstabilized lard, cottonseed oil, yellow grease, and fish oil were obtained from several commercial sources. Batches of each fat were stabilized by adding the required quantity of antioxidant and/or metal-chelating agent in the form of absolute ethanol solutions and stirring the mixtures for 15 min at 70°C. When tests could not be carried out immediately after stabilization, samples were stored at −10°F until used.

Stability of the various antioxidant-treated and untreated fats toward oxidative breakdown was measured by the modified active oxygen method (AOM) as described by Riemenschneider *et al.* (1943). The end points used to calculate "AOM-hours" were 20 meq peroxide/kg of fat for lard and grease and 70 meq peroxide/kg of fat for cottonseed oil and fish oil.

Carry-through properties of the antioxidants were evaluated by the oxygen bomb method of Gearhart *et al.* (1957a). Samples of potato chips and pastry prepared with lard were tested at 100 psi oxygen pressure; samples prepared with cottonseed oil were run at 50 psi. In all cases, 15 g of chips and 30 g of pastry were used for the tests.

Essential oils. Commercial samples of unstabilized oil of orange, U.S.P., and oil of peppermint, U.S.P., were used. Antioxidants were added in the dry state to batches of each essential oil. The mixtures were stirred at room temperature until all of the antioxidant dissolved.

Samples of approx 40 g each were stored in 4-oz screw-capped jars at room temperature (approx 75°F) and at 100°F. Effectiveness of the antioxidant treatments was determined by organoleptic panel evaluation for rancid odor, visual examination for color degradation, and measurements of increase in peroxide value during storage.

Odor evaluations were carried out at regular intervals during the storage test by a five-member panel. Samples were judged for the presence or absence of rancidity by a procedure that involved dipping a strip of filter paper into the oil and sniffing it. Each oil was examined in turn in this manner with a maximum of four samples per session. The filter-paper technique was found preferable to sniffing the jar contents directly because it gave a less intense odor, thereby permitting greater sensitivity of detection and less fatigue on the part of the panelists.

Peroxide values were determined by the method of Riemenschneider *et al.* (1943) and reported as number of days to reach a peroxide value of 50 meq/kg of essential oil.

Frozen meats. An uncured bacon belly, weighing approx 11 lb, was obtained from a local packing house less than 24 hr after slaughter. After removal of the rind, the chilled material was ground with a food-chopper attachment fitted to a food mixer using a ⅛-in. chopper plate. The ground meat was blended at low speed for several minutes with a wire whip, and then re-chilled before stabilization.

Antioxidants were added in the dry state to batches of the ground bacon belly, taking care to obtain thorough mixing. The stabilized batch was divided into 5-g portions to facilitate

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sampling during storage. The 5-g samples were individually wrapped in Saran Wrap (Dow Chemical Company) and frozen. Storage tests were conducted at both −10°F and +10°F.

The 2-thiobarbituric acid (TBA) method of Turner *et al.* (1954) was used to follow oxidation in frozen bacon belly. Analyses were made periodically on at least two replicates from each treatment.

All-meat (60% beef, 40% pork) "uncolored" frankfurters were obtained from a commercial source. "Uncolored" frankfurters were chosen primarily because preliminary work had shown that the dyes used in artificially colored frankfurters interfere substantially with TBA absorbance measurement. Approximately one month elapsed between manufacture of the frankfurters and their receipt in our laboratory, during which time the frankfurters were refrigerated but not frozen.

Frankfurters were ground and prepared for storage in the same manner as described for bacon belly. Five-gram samples were stored at both −10°F and +10°F. However, only data for the higher temperature are being reported now. The −10°F storage test has not progressed sufficiently to provide significant data.

RESULTS AND DISCUSSION

Chemical and physical properties. Table 1 shows structural formulae for gentisic acid and sodium gentisate and a number of their chemical and physical properties. Their solubilities in water are especially noteworthy in comparison with those of other food-grade phenolic antioxidants. BHA (butylated hydroxyanisole) and BHT (butylated hydroxytoluene), for example, are both insoluble in water at 25°C, whereas PG (propyl gallate) is only about 0.35% soluble.

Since fats and fat-containing foods are generally stabilized with no more than 0.02% antioxidant (based on the weight of the fat), the solubility of gentisic acid in fat appears to be more than adequate. Sodium gentisate, though less soluble in fat than gentisic acid, also appears to be sufficiently soluble on the basis of its performance in various stability tests.

Solubility data are incomplete and there may be isolated products whose stabilization cannot be accomplished because of poor solubility. In view of the excellent results obtained with gentisic acid in orange oil (these results are discussed further in the section on essential oils), the ineffectiveness of sodium gentisate was apparently due to its poor solubility in essential oils.

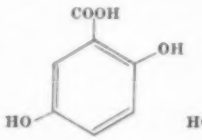
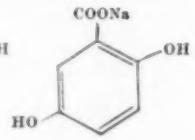
	Gentisic acid	Sodium gentisate
Structural formula		
Molecular weight	154	176
Color	white	white
Melting point, °C	200	Decomposition begins at 220
Approx solubility, 25°C, wt %		
Water	2	20
Lard	1	<0.1
Vegetable oil	1	<0.1
Propylene glycol	35	35
Orange oil	0.005	<0.005
Peppermint oil	<1	<0.005

Table 2. Evaluation of gentisic acid and sodium gentisate in stabilization of lard.

Antioxidant treatment	Lard A	Lard B		
			Oxygen bomb stability, hr	
	AOM-hr [a]	AOM-hr	Potato chips	Pastry
Control	3	6	1	2
0.01% gentisic acid	21	26	2	2
0.01% sodium gentisate	24	32	2	2
0.01% BHA	22	27	12	14
0.01% PG	47	39	8	6

[a] Hours to reach peroxide value of 20 meq/kg of fat.

Table 3. Evaluation of gentisic acid and sodium gentisate in stabilization of cottonseed oil.

Antioxidant treatment	Cottonseed oil A	Cottonseed oil B	
	AOM-hr [a]	AOM-hr [a]	Oxygen bomb stability, hr (Potato chips)
Control	10	9	8
0.01% gentisic acid	14	11	9
0.01% sodium gentisate	13	11	10
0.01% PG	26	25	10

[a] Hours to reach peroxide value of 70 meq/kg of fat.

Both gentisic acid and sodium gentisate show slight tendencies to discolor in the presence of iron. The effect is overcome with citric acid or other metal-chelating agents.

Lard and vegetable oil. Tables 2 and 3 summarize the results of stability tests with lard and cottonseed oil. The AOM data show gentisic acid and sodium gentisate to be approximately equal in potency to BHA but less effective than PG.

The oxygen bomb data in Tables 2 and 3 reveal that little, if any, gentisic acid or sodium gentisate is carried through from the stabilized fat into chips or pastry. Their poor carry-through properties indicate a high degree of heat lability under the conditions that exist during frying and pastry baking.

The superior carry-through ability of BHA, especially in pastry, is apparent from the data in Table 2. Similar results have been reported by Gearhart and Stuckey (1955).

Yellow grease. Fig. 1 illustrates the relative effectiveness of gentisic acid and BHA for stabilization of

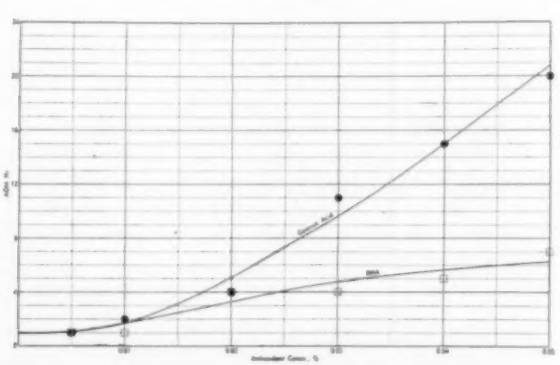


Fig. 1. Evaluation of gentisic acid in stabilization of a yellow grease (AOM-hr = hours to reach 20 meq peroxide/kg of fat).

Table 4. Evaluation of gentisic acid in stabilization of yellow grease.

Antioxidant treatment	AOM-hr [a]					
	Grease A [b] + 0.05% citric acid			Grease B		
	Gentisic acid	BHA	PG	Gentisic acid	BHA	BHT
Control	1	1	1	7	7	7
0.01%	3	3	..	17	38	11
0.03%	10	4	..	115	105	26
0.05%	31	9	29	225	168	26

[a] Hours to reach peroxide value of 20 meq/kg of fat.
[b] Same 1 AOM-hr grease used to obtain data shown in Fig. 1.

a yellow grease of poor quality (1 AOM-hr). The two antioxidants were approximately equal in potency at concentrations of 0.005 and 0.01%. At higher concentrations (up to 0.05%), gentisic acid proved to be substantially more effective than BHA.

Data in Table 4 show that the addition of citric acid to greases treated with gentisic acid and with BHA resulted in higher AOM stabilities for all samples but did not alter the relative effectiveness of the two antioxidants. Also shown in Table 4 are results obtained with a better quality of grease (7 AOM-hr). In this test, gentisic acid again demonstrated its superiority at relatively high concentrations but not at the 0.01% level.

Propyl gallate was spot-checked at one concentration only, as shown in Table 4. The single AOM value that was obtained indicates that the potency of PG in yellow grease is comparable with that of gentisic acid.

Menhaden fish oil. Table 5 summarizes AOM data showing that gentisic acid and sodium gentisate, at the 0.1% level, are slightly less effective than BHA but more effective than either PG or BHT in stabilizing menhaden fish oil. It also shows the complete ineffectiveness of all of the antioxidants at a lower concentration (0.01%). Antioxidant concentrations higher than 0.1% were not tested.

Table 5. Evaluation of gentisic acid and sodium gentisate in stabilization of menhaden fish oil.

Antioxidant	AOM-hr [a]		
	0.01% antioxidant		0.1% antioxidant [b]
	No lecithin	1% lecithin	1% lecithin
Control	1	3	3
Gentisic acid	1	2	11
Sodium gentisate	1	3	10
BHA	1	3	15
BHT	..	..	5
PG	1	3	8

[a] Hours to reach peroxide value of 70 meq/kg of fat.
[b] Lecithin was used in all tests at the 0.1% antioxidant level.

Essential oils. Data in Table 6 indicate that, in orange oil, stability toward oxidation is better with 0.005% gentisic acid than with 0.02% BHA. Because the solubility of gentisic acid in orange oil is limited to approx 0.005% at room temperature, direct comparison could not be made of BHA and gentisic acid at the 0.02% level.

A study by Gearhart *et al.* (1957b) indicated a high degree of effectiveness for BHA in orange oil, considerably greater than that obtained with either BHA or gentisic acid in the present study. No comparison with gentisic acid was made in the earlier work. Differences in the orange oils used for the two studies could be responsible for the varying effectiveness of BHA.

In addition to the peroxide values and odor panel data shown in Table 6, a clear-cut color difference was also noted. After two months at room temperature, the gentisic acid-treated sample showed little change in color from that of the original orange oil. The control sample, on the other hand, turned grayish-green during the same storage period. The color of the BHA-treated sample was also green, closely resembling that of the 2-month-old control. Objective color measurements were not carried out, but a color photograph was made to provide some record of the magnitude of the observed differences.

Odor panel evaluations with peppermint oil are shown in Table 6. The data indicate that 0.02% gentisic acid significantly increased the storage life of peppermint oil whereas the same concentration of BHA had no apparent effect. Peroxide data for the peppermint oil storage test are not given in Table 6. The data were erratic, and satisfactory end points could not be determined.

Table 6. Evaluation of gentisic acid and sodium gentisate in stabilization of orange oil and peppermint oil.

Antioxidant treatment	Stability at room temperature [a] (days)		
	Orange oil		Peppermint oil [b]
	By odor test [c]	By peroxide determination [d]	By odor test
Control	57	50	66
0.005% sodium gentisate [e]	57	53	66
0.005% gentisic acid	77	72	....
0.02% gentisic acid	....	....	90
0.02% BHA	66	54	66

[a] Approx 75°F.
[b] Peroxide data for peppermint oil too erratic for determination of valid end point.
[c] Av. judgment of 5-member organoleptic panel.
[d] Days to peroxide value of 50 meq/kg of oil.
[e] Sodium gentisate is less than 0.005% soluble in both orange and peppermint oils.

Solubility of sodium gentisate was found to be less than 0.005% in both orange oil and peppermint oil. The data in Table 6 indicate that sodium gentisate has no stabilizing effect in either of these essential oils, which may be due to its virtual insolubility.

Frozen meats. Bacon belly tends to become rancid when stored in the frozen state before being cured and smoked. The rise in TBA values is shown graphically in Fig. 2 for samples stored at both +10°F and −10°F. The data indicate that at +10°F the storage life of uncured bacon belly can be extended by 0.02% sodium gentisate or 0.02% BHA, with the gentisate being approximately twice as effective as BHA.

It can also be seen from these data that sodium gentisate was ineffective in prolonging −10°F storage life of bacon belly, whereas BHA appeared to retain its effectiveness at the lower temperature.

No attempt was made to uncover the factors responsible for the effectiveness of sodium gentisate at only one of the two storage temperatures, but this

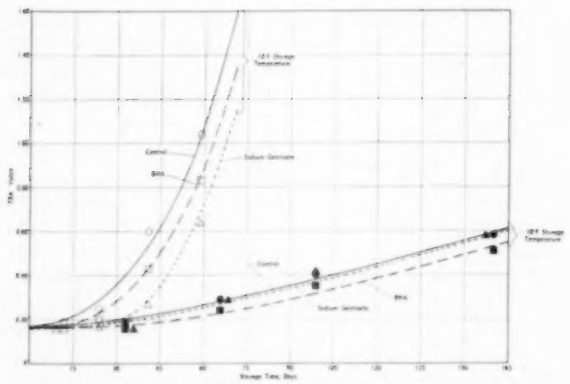


Fig. 2. Evaluation of sodium gentisate in stabilization of frozen bacon belly (antioxidants in 0.02% concentration).

phenomenon does not appear to be unique. Watts and Lehman (1952), for example, reported that, under the conditions of their test, ascorbic acid protected the color of ground pork only at refrigerator temperatures. In frozen ground pork, ascorbic acid increased rather than retarded the rate of myoglobin oxidation, and also slightly accelerated the development of rancidity.

The observed increase in rate of rancidity development for all samples at the higher storage temperature confirms similar findings by other workers reviewed by Watts (1954).

TBA values for frankfurters stored at +10°F are shown in Fig. 3. Little, if any, difference existed between the potency of gentisic acid, sodium gentisate, ascorbic acid, and BHA under the conditions of the test. At a concentration of 0.02%, each substantially slowed rancidity development during +10°F storage.

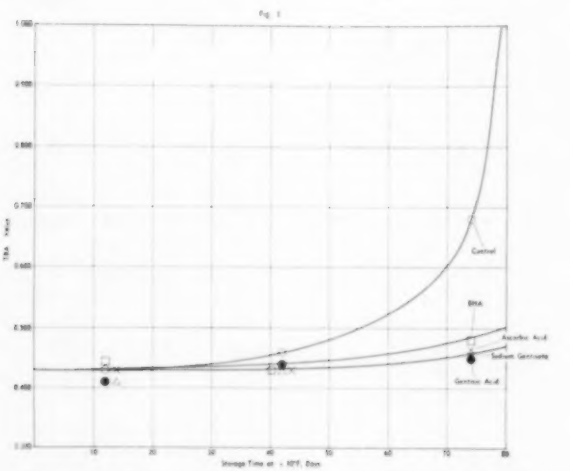


Fig. 3. Evaluation of gentisic acid and sodium gentisate in the stabilization of frozen frankfurters (antioxidants in 0.02% concentration).

The relatively high TBA value (0.430) at the start of the storage test was apparently due in part to the myoglobin pigments extracted from the frankfurter. In interpreting the data, it was assumed that this source of error remained constant and could be disregarded.

A −10°F storage test is in progress but has not yet yielded sufficient data to warrant inclusion in this report.

Conclusions. Effectiveness of gentisic acid and sodium gentisate as antioxidants does not appear to be limited to any one class of foods, as illustrated by excellent results obtained in such dissimilar products as essential oils and inedible grease. Their relatively high water solubilities, in comparison with other food-grade phenolic antioxidants, should be advantageous in achieving good antioxidant dispersion within foods such as meats and fish. However, additional work is needed to establish their value in applications of this type.

ACKNOWLEDGMENT

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REFERENCES

Beilstein, F. K. 1927. "Handbuch der Organischen Chemie." 4th ed. Julius Springer, Berlin, 384.

Clarke, E. C., and R. E. Mosher. 1953. Phenolic compounds in treatments of rheumatic fever. II. Metabolism of gentisic acid and the ethanolamid of gentisic acid. *Circulation* **7**, 337.

Drill, V. A. 1958. "Pharmacology in Medicine." 2nd ed. McGraw-Hill Book Co., N. Y.

Gearhart, W. M., and B. N. Stuckey. 1955. A comparison of commercially used phenolic antioxidants in edible animal fats. *J. Am. Oil Chemists' Soc.* **32**, 386.

Gearhart, W. M., B. N. Stuckey, and J. J. Austin. 1957a. Comparison of methods for testing the stability of fats and oils, and of foods containing them. *J. Am. Oil Chemists' Soc.* **34**, 427.

Gearhart, W. M., B. N. Stuckey, and E. R. Sherwin. 1957b. Effects of antioxidants on the stability of orange oil. *Food Technol.* **11**, 260.

Morris, S. G., and R. W. Riemenschneider. 1949. Antioxidant properties of polyhydroxybenzoic acids and their esters, and other nuclear substituted polyphenols. *J. Am. Oil Chemists' Soc.* **26**, 638.

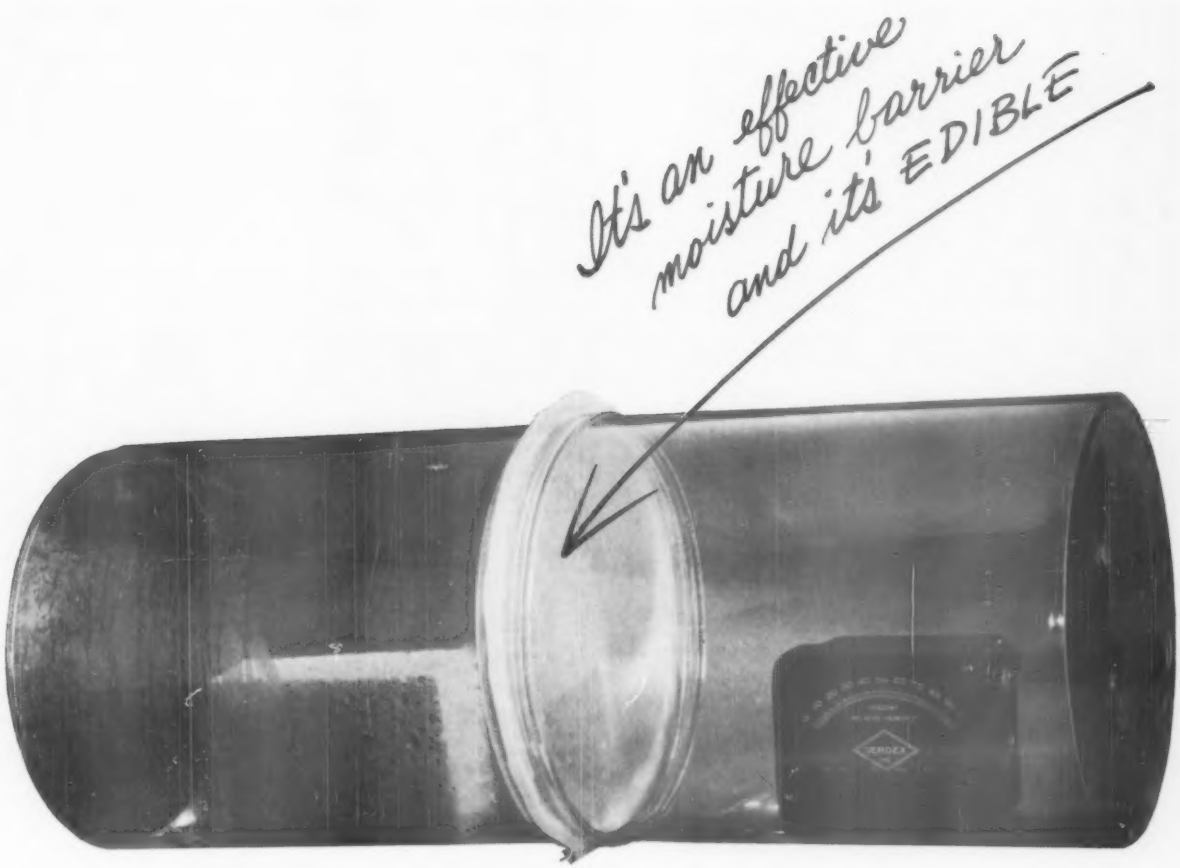
Riemenschneider, R. W. 1947. Oxidative rancidity and the use of antioxidants. *Trans. Am. Assoc. Cereal Chemists* **5**, 50.

Riemenschneider, R. W., J. Turer, and R. M. Speck. 1943. Modifications of the Swift stability test. *Oil & Soap* **20**, 169.

Turner, E. W., W. D. Paynter, E. J. Montie, M. W. Bessert, G. M. Struck, and F. C. Olson. 1954. Use of the 2-thiobarbituric acid reagent to measure rancidity in frozen pork. *Food Technol.* **8**, 326.

Watts, B. M. 1954. Oxidative rancidity and discoloration in meat. *Advances in Food Research* **5**, 1.

Watts, B. M., and B. T. Lehmann. 1952. Ascorbic acid and meat color. *Food Technol.* **6**, 194.



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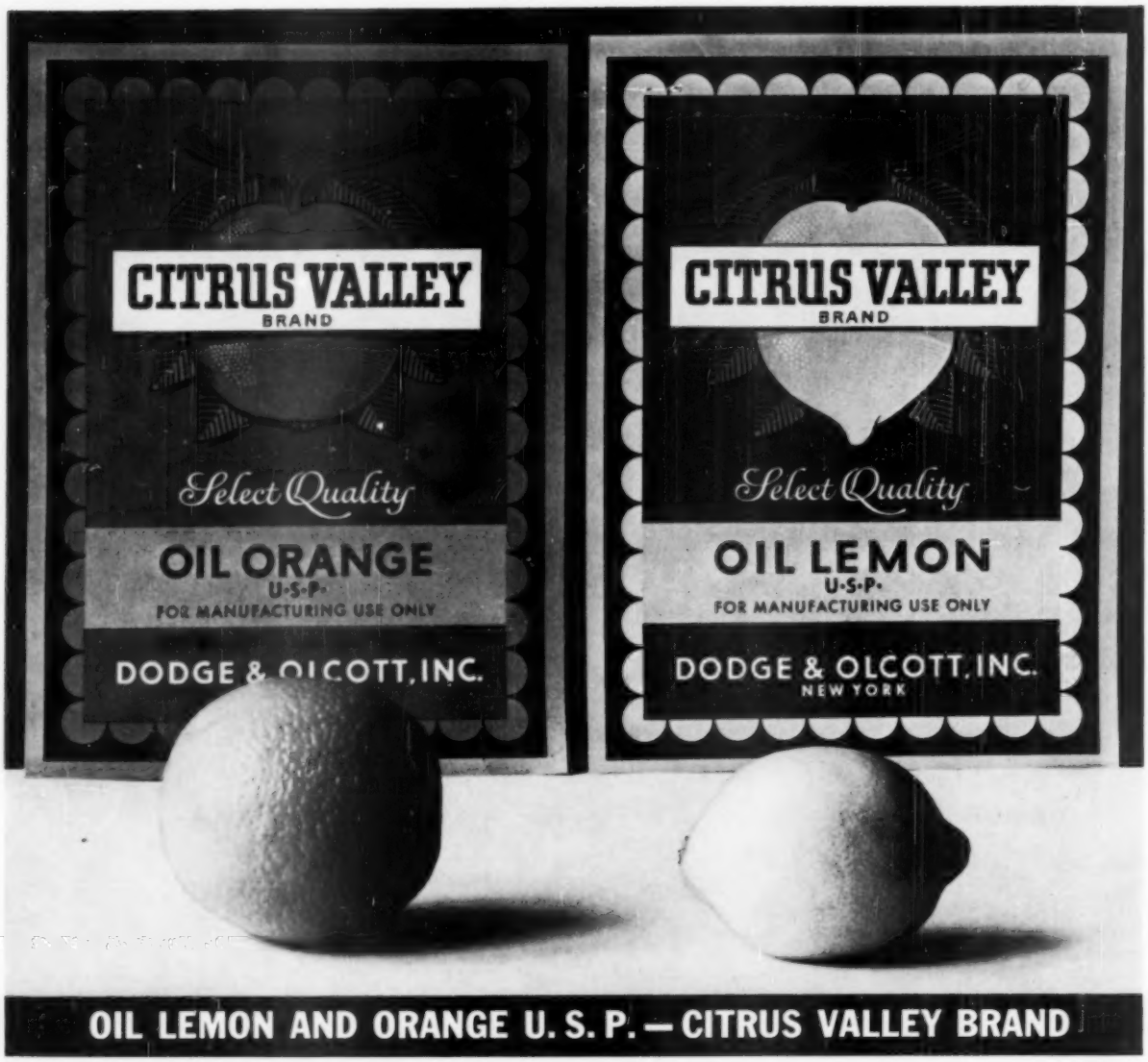

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Low-Temperature Handling of Sterilized Foods. IV.

Color and Flavor of Canned Vegetables[a]

(Manuscript received June 21, 1961)

Frederick M. Joffe, Elizabeth F. Stier, Dolores C. Bongolan, Arnold I. Epstein, and C. Olin Ball

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SUMMARY

Effects of processing methods on flavor and color attributes indicate that HTST processing was generally superior to conventional processing and was comparable to or better than frozen storage immediately after the processing. Retention of the advantage was dependent on storage time and temperature. If the storage temperature was maintained at 35–50°F, the HTST samples were preferable to conventional samples for 24 months, and comparable to or better than the frozen samples in all attributes except hue. At 25 and 85°F, however, the retention of favorable color and flavor attributes rapidly diminished. Flavor degradation was most noticeable in storage at 85°F. Of the products examined, whole-kernel corn appeared best suited for HTST processing.

In recent years, high-temperature short-time sterilization (HTST) of foods has become an increasingly important factor in thermal processing. Several papers are concerned with the application of HTST sterilization processes (Anon., 1948; Clifcorn *et al.*, 1950; Epstein and Ball, 1960; Havighorst, 1953; Morgan, 1960; Vetter *et al.*, 1957), and patents have been granted for HTST equipment. This series of papers discusses biochemical factors (Brody *et al.*, 1960) and color (Epstein *et al.*, 1960) of certain HTST-sterilized products; however, the general areas of palatability and appearance have been largely neglected. To evaluate the effects of HTST sterilization on these quality aspects, and in particular to evaluate the effects of low-temperature storage on HTST-sterilized food, an extensive study was undertaken of the hue, brightness, flavor difference, and flavor preference of several products.

This paper summarizes color and flavor comparisons of HTST, frozen, and conventionally canned vegetables, evaluated throughout a 24-month storage period. The results are compared with those previously reported on biochemical factors (Brody *et al.*, 1960).

EXPERIMENTAL PROCEDURE

The products evaluated were green peas, whole-kernel corn, asparagus, and green beans. Preparation, canning, and thermal processing have been described (Brody *et al.*, 1960; Epstein and Ball, 1960; Epstein *et al.*, 1960). Table 1 lists the process times and retort temperatures. The HTST samples were packed in 211 × 011 plain cans, whereas conventionally processed and frozen samples were packed in 211 × 300 plain cans. Samples of HTST and conventionally processed products were stored at 25, 35, 50, and 85°F. All samples were evaluated immediately after processing and after 3, 6, 12, 18, and 24 months of storage. The frozen samples were stored at 0°F.

Color evaluations were made with a Gardner Color Difference Meter. Measurements were recorded for L, a_L and b_L, from which were determined hue values ($\tan^{-1} a/b$) and brightness (L). Table 2 lists the standard plates used for evaluation of each product. Three replicates, each containing the solid contents of two cans, were used for analysis of color of conventional and frozen samples; six cans were used for HTST samples.

Table 1. Processing conditions for HTST and conventionally canned vegetables.

Product	Retort temperature (°F)		Heating time		Cooling time	
	HTST	Conv.	HTST (sec)	Conv. (min)	HTST (min)	Conv. (min)
Green peas	300	250	70	15	5	15
Green beans	300	245	60	15	5	15
Asparagus	300	240	65	27	5	15
Whole-kernel corn	300	245	66	40	5	15

The procedure used for flavor-difference analysis was based on methods described by Mahoney *et al.*, 1957. The multiple-comparison technique presented in that article was used with the following change: The "acceptable or not acceptable" choices were replaced by "better than, comparable to, or poorer than" the check sample. For this reason the two-panel test was changed to a twenty-member three-panel test. Duplicates of each sample were tasted at two of the three panel meetings. The check samples were conventionally processed, and stored at 35°F. Mean difference values and flavor preferences were determined for each of the nine samples (four storage temperatures each for HTST and conventional samples, and one storage temperature for frozen samples) with points 1–5 presented as none, slight, moderate, large, and extreme, respectively.

Table 2. Standard color plates for color evaluation of vegetables.

Product	National Bureau of Standards plate number	Values of standard plate		
		L	a_L	b_L
Green peas	12	55.7	−22.3	12.2
Green beans	15	58.2	−21.0	14.5
Asparagus	12	55.7	−22.3	12.2
Whole-kernel corn	35	73.4	1.0	31.7

Explanation of Tables 3 to 6. In section A, Processing Method includes HTST, conventional, and frozen methods.

The length of storage time in months, which was considered for Section C, can be seen in the storage time analysis (section D).

Joined circles indicate significant differences at the 5% level. Dotted lines indicate no significant difference.

[a] Presented before the Twenty-first Annual Meeting of the Institute of Food Technologists, May 9, 1961.

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RESULTS AND DISCUSSION

Color changes due to processing and storage. The results of statistical analysis of color attributes are presented in Tables 3–6. These analyses show statistical differences but do not indicate which treatment produced the most desirable effect. Preference of color attributes is presented here on the basis of similarity to the original material, i.e., rated as preferable are the hue values that agreed most closely with those of the original, unprocessed material.

Of the two color attributes evaluated, the hue values were more affected by processing, storage temperature, and storage time than were the brightness values. The highest correlation with both color attributes was shown by storage time. Processing method showed a medium degree of correlation, and storage temperature a very low one.

The hue values were maintained best in frozen storage. Generally, the desirable greenness or yellowness was appreciably higher in the frozen samples than in the HTST or conventional samples. HTST processing was considerably better for retention of hue than conventional processing. The interaction of storage time with method of processing was particularly noticeable here. HTST samples appeared to retain a desirable hue in some measure for 6–12 months of storage, whereas conventional samples generally deteriorated to a noticeable extent within the first three months.

The retention of brightness was most favorable for HTST samples. In particular, the brightness values were considerably higher in HTST whole-kernel corn than in frozen or conventional samples. Frozen samples retained their brightness values for longer periods than did conventional samples, but for shorter periods than did HTST samples.

For both HTST and conventional samples, the effects of storage temperature on hue values were noticeable only between samples stored at 25°F and those stored at 85°F, and there were no significant effects of storage temperature on brightness values. Samples stored at 25°F retained the characteristic hue for 3–6 months, whereas samples stored at 85°F had, after 3 months of storage, hue values significantly different from the initial values.

Flavor changes due to processing and storage. The flavor analysis is based primarily on evaluations of differences rather than on preferences. Difficulty was encountered in judging preference between processes with a taste panel of twenty members. Differences are invariably recognized between HTST, conventional, and frozen samples; however, the preference displayed for a particular sample is frequently split between better-than reference and poorer-than reference.

For example, with whole-kernel corn stored for 6 months, all panel members recognized the differences between HTST, frozen, and conventional samples. One-third of the panel members preferred HTST samples to the conventional samples, one-third rated the HTST samples poorer than the conventional sample, and the remaining third recognized a difference in the flavor of the samples but rated the HTST as comparable to the conventional samples on the preference scale. Reaction to frozen samples was the same.

This anomaly in preference rating can best be classified as a matter of "flavor environment" of panel members, and since this study is primarily in food science rather than psychology, flavor preference is reported only where indications for its presentation are clear.

Table 3. Color of green peas.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	....	1.0
Storage temperature	....	5.0
Storage time	0.1	0.1

B. Multiple comparison of processing method (mean values)

Method	Hue signif. diff.	Rank
HTST	○ ○	2
Conventional	○ ○	3
Frozen	● ○	1

C. Multiple comparison of storage temperature (mean values)

Storage temperature (°F)	Hue signif. diff.
25	○
35	|
50	|
85	○

D. Multiple comparison of storage time (mean values)

Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0	○○○○○	○○○○
3	○ ○○	○ ○
6	○○ ○	○ ○
12	○ ○○	○ ○
18	○ ○○	○ ○
24	○ ○○	○○○

Table 4. Color of whole-kernel corn.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	0.1	5.0
Storage temperature	....	....
Storage time	0.1	0.1

B. Multiple comparison of processing method (mean values)

Method	Brightness signif. diff.	Rank	Hue signif. diff.	Rank
HTST	○ ○	1	●	1
Conventional	○ |	3	|	2
Frozen	○	2	○	3

C. Multiple comparison of storage time (mean values)

Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0	○○○	●○○○○
3	○ ○○	○ ○
6	○ ○○	○ ○
12	○ ○○	○ ○
18	○ ○○	○ ○
24	○ ○○	○ ○

Table 5. Color of green beans.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	0.1	0.1
Storage temperature	....	1.0
Storage time	5.0	0.1

B. Multiple comparison of processing method (mean values)

Method	Brightness signif. diff.	Rank	Hue signif. diff.	Rank
HTST	●	1	○	2
Conventional	○ ○	2	○	3
Frozen	○	1	○ ○	1

C. Multiple comparison of storage temperature (mean values)

Storage temperature (°F)	Hue signif. diff.
25	○
35	○
50	○
85	○

D. Multiple comparison of storage time (mean values)

Storage time (months)	Hue signif. diff.
0	○
3	○
6	○
12	○
18	○

Differences in flavor due to process method were significant immediately after processing and throughout storage. The differences between HTST samples and the check were less noticeable than between frozen samples and the check, and conventional samples were initially rated as similar to check (as expected since the check sample was conventionally processed). The difference values indicated for frozen samples diminished through storage, but remained higher than HTST difference values in all cases (Table 7).

Table 6. Color of asparagus.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	....	5.0
Storage temperature	....	....
Storage time	0.1	0.1

B. Multiple comparison of processing method (mean values)

Method	Hue signif. diff.	Rank
HTST	○ ○	3
Conventional	○	2
Frozen	○ ○	1

C. Multiple comparison of storage time (mean values)

Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0	○	○ ○ ○ ○ ○
3	○	○ ○
6	○	○
12	○	○

The preference for HTST samples was higher than for frozen samples immediately after processing, and generally continued for 3–6 months. After 6 months of storage, however, HTST samples were rated as poorer than the check whereas there was no preference difference between frozen and conventional samples after 12 months.

The effects of storage temperature on flavor differences were more noticeable for conventional samples than for HTST samples. However, HTST samples stored at 35 and 50°F were rated as preferable to the check up to 6 months of storage, and those stored at 85°F were rated as poorer than the check after 3 months of storage. Differences between HTST samples due to storage temperature were negligible after 6 months.

Table 7. Mean hedonic-scale ratings for effects of processing methods on the flavor of vegetables.

Product	Storage time (months) 0	3	6	12	18	24
Green peas						
HTST	3.75	4.36	3.01	3.10	3.02	3.34
Conv.	1.86*	2.36*	2.02	2.33*	1.94*	1.73*
Frozen	5.27	5.07	4.57	4.39	4.81	NA
Green beans						
HTST	3.50	3.29	3.87	3.88	3.67	3.06
Conv.	1.43*	1.78*	2.00	2.01*	1.43*	1.35*
Frozen	4.55	4.65	4.59	5.69	4.79	4.05
Whole-kernel corn						
HTST	3.81	3.66	4.44	3.73	3.47	4.14
Conv.	2.28*	2.44	2.29	2.43	1.92*	2.25*
Frozen	3.97	4.77	4.70	4.32	3.69	NA
Asparagus						
HTST	3.04	3.66	2.63	3.23	3.02	3.99
Conv.	2.04*	2.15*	1.60*	2.01*	1.70*	3.16
Frozen	3.55	4.38	3.53	3.75	NA	NA

* Not significantly different from check at the 0.1% level.

The effects of storage temperature on flavor of conventional samples were most noticeable between samples stored at 25°F and the check, and those stored at 85°F and the check. The 85°F samples deteriorated rapidly in flavor after 3 months, whereas the 25°F samples showed only slightly poorer flavor than the check throughout the storage period. Conventional samples stored at 35 and 50°F exhibited optimum flavor retention.

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REFERENCES

Anonymous. 1948. New "flash-heating" process announced at conference. *Canner* **106**(5), 18.

Brody, A. L., K. Bedrosian, and C. O. Ball. 1960. Low temperature handling of sterilized foods. V. Biochemical changes in storage. *Food Technol.* **14**, 552.

Clifcorn, L. E., D. F. Peterson, J. M. Boyd, and J. W. O'Neill. 1950. A new principle for agitating in processing of canned foods. *Food Technol.* **4**, 450.

Epstein, A. I., and C. O. Ball. 1960. Low temperature handling of sterilized foods. I. Design of equipment and outline of processes used. *Food Technol.* **14**, 363.

Epstein, A. I., E. F. Stier, and C. O. Ball. 1960. Low temperature handling of sterilized food. II. The storage stability of color of high temperature short time sterilized green peas. Presented before the 20th Annual Meeting, Institute of Food Technologists, San Francisco, May 18.

Havighorst, C. R. 1953. New canning process. *Food Eng.* **25**, 76.

Mahoney, C. H., H. L. Stier, and E. A. Crosby. 1957. Evaluating flavor differences in canned food. II. Fundamentals of the simplified procedure. Symposium of the Institute of Food Technologists on Methodology of Sensory Testing. *Food Technol.* **11**, 37.

Morgan, A. I., Jr. 1960. Use of direct steam injection in food processing. *J. Dairy Sci.*, **43**, 1693.

Vetter, J. L., A. I. Nelson, and M. P. Steinberg. 1957. Direct steam injection for high temperature short time sterilization of whole-kernel corn. *Food Technol.* **11**, 271.

Low-Temperature Handling of Sterilized Foods. VI.

Color and Flavor of Canned Soups, Tomato Juice, and Evaporated Milk [a,b]

(Manuscript received May 9, 1961)

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SUMMARY

Color and flavor were evaluated for several liqueform products processed by HTST sterilization, conventional canning, and freezing, and stored at 25, 35, 50, and 85°F for 3, 6, 12, 18, and 24 months. Color was affected most by storage time, the most rapid changes occurring during the first 6 months of storage. Hue was best maintained by freezing; brightness by HTST sterilization. Conventional canning produced the greatest changes in color due to processing and storage. Flavor was affected most by processing method, with HTST sterilization initially most preferable. Storage at 35°F was optimum, followed by 50, 25, and 85°F, respectively.

COLOR AND FLAVOR evaluations of canned vegetables (Joffe *et al.*, 1961) and biochemical evaluations of several products (Brody *et al.*, 1960) have been reported on in this continuing study of the quality attributes of sterilized foods. This paper presents the results of color and flavor evaluation of liqueform products. Throughout this study the object has been to evaluate the effects on the quality factors of food products of high-temperature short-time (HTST), conventional, and freeze processing methods, of storage temperature, and of storage time. The information obtained has been valuable in analysis of causative factors in the deterioration of food quality.

EXPERIMENTAL PROCEDURE

The following products were evaluated: Two runs of oyster stew, evaporated milk, pea soup with ham, and tomato juice; one run of vegetable beef soup, cream of potato soup, and shrimp soup. Processing methods, storage conditions, and evaluation procedures have been described (Epstein and Ball, 1960; Joffe *et al.*, 1961). The processing times and temperatures are listed in Table 1; standard color plates used for evaluation of hue and brightness are listed in Table 2. The storage temperatures used were: frozen samples, 0°F; HTST and conventional samples, 25, 35, 50, and 85°F.

RESULTS AND DISCUSSION

Color evaluations. The effects of processing methods, storage temperature, and storage time on the brightness and hue of liqueform products were evaluated. Of the three effects, storage time produced the greatest number of significant differences for both brightness and hue. This was evidenced by the fact that the greatest changes in color were experienced during the first 6 months of storage. Both hue and brightness values for all processing methods changed most rapidly during this period. Hue values continued to drop throughout the storage period, but brightness values generally leveled off during the 6–18-month period, after which there was a further decline in brightness. Of the three processing meth-

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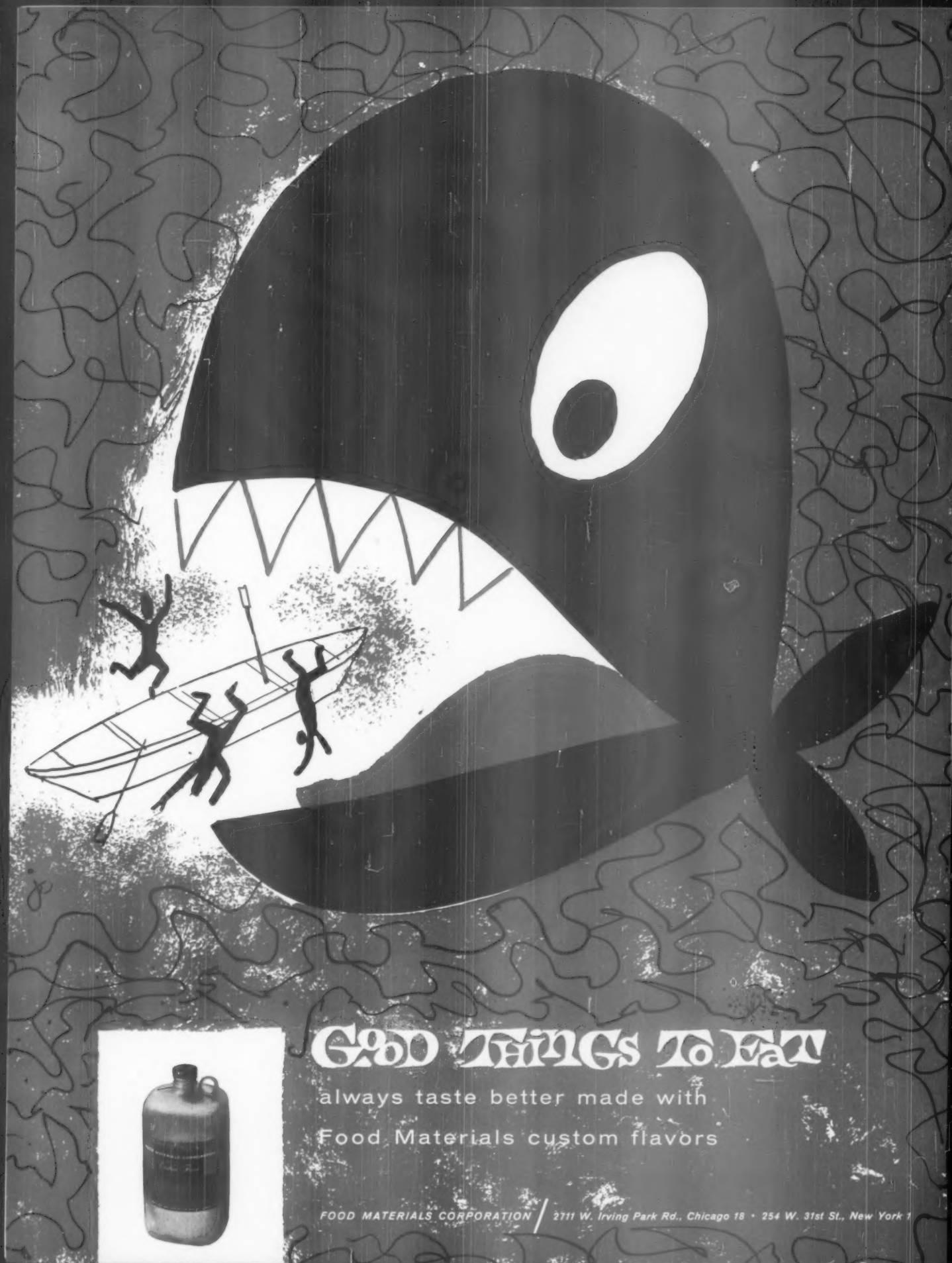
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ods, conventional canning caused the greatest differences in both hue and brightness due to processing and storage. The conventionally processed samples lost their characteristic hue and brightness to a large extent because of the extensive heat treatment, but both hue and brightness deteriorated further throughout the storage period.

The HTST-processed samples exhibited the smallest changes in brightness values due to the effects of storage. Immediately after processing, brightness values were higher for HTST samples than for frozen samples except in evaporated milk. These higher brightness values for HTST samples continued throughout the storage period. Differences in hue values due to processing were evidenced only in one-half of the products examined. For the products where differences were significant, frozen samples maintained the characteristic hue values better than the HTST samples at the initial evaluation after

Table 1. Processing conditions for HTST-canned and conventionally canned products.

Product	Retort temperature (°F)		Heating time		Cooling time (min)	
	HTST	Conventional	HTST (sec)	Conventional (min)	HTST	Conventional
Oyster stew	300	245	85	40	2	10
Evaporated milk	300	242	75	20	2	15
Pea soup with ham	300	245	75	53	2	10
Tomato juice	300	212	60	25	2	15
Shrimp soup	300	245	130	53	2	10
Vegetable beef soup	300	245	110	53	2	10
Cream of potato soup	300	245	180	53	2	10

Table 2. Standard plates for color evaluations.

Product	NBS plate number	L	a_L	b_L
Oyster stew	00	85.3	− 1.2	+ 1.3
Evaporated milk	00	85.3	− 1.2	+ 1.3
Cream of potato soup	00	85.3	− 1.2	+ 1.3
Tomato juice	48[a]	26.5	+26.6	+12.7
Pea soup with ham	15	58.2	−21.0	+14.5
Shrimp soup	35	73.4	+ 1.0	+31.7
Vegetable beef soup	35	73.4	+ 1.0	+31.7

[a] Gardner color plate number.

Table 3. Color of oyster stew, run No. 4.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	0.1	5.0
Storage temperature	....	5.0
Storage time	0.1	0.1

B. Multiple comparison of processing method (mean values)

Method	Brightness signif. diff.	Rank	Hue signif. diff.	Rank
HTST		1		2
Conventional		3		3
Frozen		2		1

C. Multiple comparison of storage temperature (mean values)

Storage temperature (°F)	Hue signif. diff.
25	
35	
50	
85	

D. Multiple comparison of storage time (mean values)

Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0		
3		
6		
12		
18		
24		

Table 4. Color of oyster stew, run No. 17.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	0.1	5.0
Storage temperature	....	....
Storage time	0.1	0.1

B. Multiple comparison of processing method (mean values)

Method	Brightness signif. diff.	Rank	Hue signif. diff.	Rank
HTST		1		1
Conventional		3		3
Frozen		2		2

C. Multiple comparison of storage temperature (mean values)

Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0		
3		
6		
12		
18		

Table 5. Color of cream of potato soup, run No. 16.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	5.0	....
Storage temperature	1.0	....
Storage time	0.1	0.1

B. Multiple comparison of processing method (mean values)

Storage temperature (°F)	Brightness signif. diff.
25	
35	
50	
85	

C. Multiple comparison of storage temperature (mean values)

Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0		
3		
6		
12		
18		
24		

processing. However, after 6–12 months of storage time, characteristic hue values deteriorated less in HTST samples than in frozen samples.

Storage temperature was generally not a significant factor in the effects on hue, and was significant in only one-third of the products examined for brightness. When storage temperature did affect brightness values, 35°F was the optimum storage temperature and 85°F produced the most rapid deterioration of brightness values. When the effects of storage temperature on HTST and conventionally processed samples were separated, neither hue nor brightness values of conventionally processed samples were affected by storage temperature, but brightness values of HTST products were significantly lowered by storage at 85°F. Hue values of HTST samples were maintained at optimum by storage at 35°F.

Tables 3–13 summarize the results of color evaluations. Joined dots indicate differences significant at the 5% level; dashes indicate no significant difference. Multiple comparisons are not presented when a particular treatment did not significantly affect both brightness and hue values.

Flavor evaluations. Table 14 summarizes the effects of processing method, storage temperature, and storage time on flavor difference and flavor preference expressed by a 20-member flavor panel. A five-point hedonic scale was used for rating flavor difference with points 1 to 5 presented as none, slight, moderate, large, and extreme, respectively. Hedonic-scale values for conventional samples at the initial evaluation (zero time storage, after processing) are

Table 6. Color of evaporated milk, run No. 7.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	1.0	0.1
Storage temperature	1.0	....
Storage time	1.0	0.1

B. Multiple comparison of processing method (mean values)

Method	Brightness signif. diff.	Rank	Hue signif. diff.	Rank
HTST	○ ○	2	○ ○	2
Conventional	○	3	○	3
Frozen	○ ○	1	○ ○	1

C. Multiple comparison of storage temperature (mean values)

Storage temperature (°F)	Brightness signif. diff.
25	○
35	○
50	○
85	○ ○ ○

D. Multiple comparison of storage time (mean values)

Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0	○	○ ○
3	○	○
6	○	○
12	○ ○ ○	○ ○
18		○
24	○	○

Table 7. Color of evaporated milk, run No. 19.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	....	5.0
Storage temperature	....	....
Storage time	....	1.0

B. Multiple comparison of processing method (mean values)

Method	Hue signif. diff.	Rank
HTST		2
Conventional	○	3
Frozen	○	1

C. Multiple comparison of storage temperature (mean values)

Storage time (months)	Hue signif. diff.
0	○ ○ ○
3	○
6	○
12	○
18	○ ○
24	○ ○

Table 8. Color of vegetable soup with beef, run No. 5.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	....	....
Storage temperature	0.1	....
Storage time	0.1	1.0

B. Multiple comparison of storage temperature (mean values)

Storage temperature (°F)	Brightness signif. diff.
25	○ ○ ○
35	○
50	○ ○ ○
85	○

C. Multiple comparison of storage time (mean values)

Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0	○ ○ ○ ○ ○	
3	○ ○	
6	○ ○ ○	
12	○ ○ ○ ○	
18	○ ○ ○ ○	
24	○ ○ ○ ○ ○	○

a calibration of the taste panel. The check sample was processed conventionally, so the degree of difference indicated by the panel is, in effect, a calibration of its accuracy.

Of the three factors, processing method was the most significant factor affecting both of the flavor attributes. Storage time, over the range studied, was more significant than storage temperature.

Of the three processing methods, conventional processing produced the least significant differences from the check. This was expected since the check sample was conventionally processed and stored at 35°F. The frozen samples were initially rated as being "more different" from the check than the

HTST samples. However, the HTST samples generally (in 80% of the cases) received higher preference ratings than frozen samples at the initial evaluation time.

After 3 months of storage the HTST samples were rated as "poorer than" the check in all cases, and for the five products where preference of frozen samples was indicated, four of these products were rated as "poorer than" the check. This result was taken as an indication that 3 months of storage was optimum for conventionally processed samples, and not that the flavor of HTST and frozen samples underwent extensive deterioration during the 0–3-month storage period. The basis for this explanation will become evident from the results presented below.

Table 9. Color of tomato juice, run No. 1.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	5.0	....
Storage temperature	0.1	....
Storage time	0.1	0.1

B. Multiple comparison of processing method (mean values)

Method	Brightness signif. diff.	Rank
HTST	●	2
Conventional	○	2
Frozen	○	1

C. Multiple comparison of storage temperature (mean values)

Storage temperature (°F)	Brightness signif. diff.
25	○
35	○
50	●
85	○

D. Multiple comparison of storage time (mean values)

Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0	○	○
3	○	○
6	●	○
12	●	●
18	○	○

Table 10. Color of tomato juice, run No. 11.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	....	....
Storage temperature	....	....
Storage time	0.1	0.1

B. Multiple comparison of storage time (mean values)

Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0	●	○
3	○	○
6	○	●
12	●	○
18	●	●
24	○	○

Table 11. Color of pea soup with ham, run No. 6.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	....	0.1
Storage temperature	1.0	....
Storage time	0.1	0.1

B. Multiple comparison of processing method (mean values)

Method	Hue signif. diff	Rank
HTST	●	1
Conventional	○	3
Frozen	○	2

C. Multiple comparison of storage temperature (mean values)

Storage temperature (°F)	Brightness signif. diff.
25	○
35	○
50	●
85	●

D. Multiple comparison of storage time (mean values)

Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0	○	○
3	○	○
6	○	●
12	●	○
18	●	○
24	●	●

At 6, 12, 18, and 24 months, the HTST samples continued to display significant flavor differences from the check for 80–90% of the products. The flavor preference values for HTST samples indicated that all samples were "poorer than" the check at the 3-month evaluation time; at the 6-month evaluation time, however, the flavor preference ratings were evenly split between "poorer than" and "better than the check." After 12 months of storage the HTST samples were preferred to the check in approx 60% of the cases. Between 12 and 24 months the flavor preference for HTST samples gradually declined, by 24 months being rated as "poorer than" the check in 80% of the cases.

The number of significant differences from the check for frozen samples was comparable to those for HTST samples throughout the entire storage period. After 3 months, however, the flavor preference for frozen samples was generally split between "better than" and "poorer than" the check. The reason might have been the fact that evaporated milk, tomato juice, and the formulations used for the frozen soups (identical to the formulations used for the thermally processed samples) generally exhibited flavors that were "unusual" though not necessarily unpalatable to the panel.

The effects of storage temperature on the flavor attributes were similar to those reported for color attributes. Storage temperature generally did not affect the flavor of conventionally processed products

Table 12. Color of pea soup with ham, run No. 15.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	0.1	0.1
Storage temperature	0.1	1.0
Storage time	0.1	0.1

B. Multiple comparison of processing method (mean values)

Method	Brightness signif. diff.	Rank	Hue signif. diff.	Rank
HTST	○ ●	1	○ ○	1
Conventional	○ ●	2	● ○	3
Frozen	○ ○	3	○ ○	2

C. Multiple comparison of storage temperature (mean values)

Storage temperature (°F)	Brightness signif. diff.	Hue signif. diff.
25	○	○
50	○	○
50	○	●
85	○	○

D. Multiple comparison of storage time (mean values)

Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0	○	○
3	●	○
6	○	●
12	●	○
18	○	●
24	●	●

Table 13. Color of shrimp soup, run No. 18.

A. Significant effects of treatments

Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	....	....
Storage temperature	....	5.0
Storage time	0.1	0.1

B. Multiple comparison of processing temperature (mean values)

Storage temperature (°F)	Hue signif. diff.
25	○
35	○
50	
85	

C. Multiple comparison of storage time (mean values)

Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0	○	○
3	○	○
6	○	○
12	○	●
18	○	●
24	●	○

except 85°F, at which flavor deterioration was extensive after 3 months of storage. The respective flavor preference values for HTST samples, from better to poorer, were 35, 50, 25, and 85°F.

Table 14. Mean hedonic scale values[a] for the effects of processing methods on flavor difference.

Product		Storage time (months) 0	3	6	12	18	24
1) Oyster stew							
Run 4	HTST	3.75	2.65	3.46	3.26	NA	4.05
	Conv.	1.44	1.74	1.44	2.32	NA	2.27
	Froz.	2.48	2.36	3.28	3.37	NA	4.12
Run 17	HTST	3.50	4.56	3.70	3.47	3.13	3.86
	Conv.	1.43	1.31	1.48	1.58	1.89	1.53
	Froz.	4.37	5.03	4.91	4.02	NA	NA
2) Pea soup with ham							
Run 6	HTST	2.46	3.84	3.71	3.94	4.24	3.71
	Conv.	1.48	1.19	2.10	1.92	2.09	2.12
	Froz.	1.89	2.41	2.84	3.34	3.54	3.01
Run 15	HTST	2.84	3.48	NA	3.57	3.99	3.27
	Conv.	1.72	2.19	NA	1.67	1.53	1.65
	Froz.	2.90	3.31	NA	2.57	3.83	NA
3) Evaporated milk							
Run 7	HTST	2.55	2.25	3.00	3.03	3.12	2.78
	Conv.	1.53	1.49	1.83	1.69	2.17	1.96
	Froz.	4.48	4.02	4.90	4.89	4.03	3.81
Run 19	HTST	3.05	2.52	2.90	2.83	3.34	3.38
	Conv.	1.45	1.59	1.56	1.77	2.05	2.30
	Froz.	3.22	5.29	3.67	2.67	NA	NA
4) Vegetable soup with beef							
Run 5	HTST	2.21	3.04	2.98	3.42	3.85	3.34
	Conv.	1.13	1.38	1.66	1.75	1.69	2.02
	Froz.	1.88	1.80	3.17	2.75	4.02	2.58
5) Potato soup							
Run 16	HTST	3.12	4.64	4.31	4.22	4.27	4.34
	Conv.	1.27	1.43	1.69	2.02	1.99	1.89
	Froz.	3.84	3.76	4.50	3.89	NA	NA
6) Shrimp soup							
Run 18	HTST	3.10	3.25	3.31	3.27	3.29	4.05
	Conv.	1.48	1.41	1.98	1.83	1.90	1.92
	Froz.	3.89	1.64	3.51	2.74	NA	NA
7) Tomato juice							
Run 11	HTST	1.87	2.94	3.00	3.14	3.68	3.14
	Conv.	1.99	2.75	2.51	2.63	2.77	2.52
	Froz.	3.55	4.59	4.86	5.45	4.10	NA

[a] Numerical values represent degree of difference from the standard check. Conv. = conventionally canned. Froz. = frozen.

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REFERENCES

Brody, A. L., K. Bedrosian, and C. O. Ball. 1960. Low temperature handling of sterilized foods. V. Biochemical changes in storage. *Food Technol.* **14**, 552.

Epstein, A. I., and C. O. Ball. 1960. Low temperature handling of sterilized foods. I. Design of equipment and outline of processes used. *Food Technol.* **14**, 363.

Joffe, F. M., Elizabeth F. Stier, Dolores C. Bongolan, Arnold I. Epstein, and C. O. Ball. 1961. Low-temperature handling of sterilized foods. IV. Color and flavor evaluations of canned vegetables. Presented at the 21st annual meeting of the Institute of Food Technologists, May 9, 1961. *Food Technol.* **15**, 507.

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Copper and Iron Content of Ice Cream and Mellorine and Its Significance in the Development of Oxidative Flavor Defects*

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SUMMARY

An analysis of 107 samples of ice cream and mellorine showed that the chocolate-flavored samples usually contained more copper and iron than the vanilla or strawberry samples. The means of copper content of the vanilla, strawberry, and chocolate samples were respectively 0.305, 0.390, and 1.160 ppm. No relation could be established between oxidative flavor defects and the copper or iron content of the samples. The addition of 0.82 ppm of copper after homogenization caused a metallic flavor in vanilla ice cream after 11 days of storage at −25°C. When copper was added before homogenization the rate of development of oxidative flavor defects was much slower. Iron did not seem to be involved in the development of a metallic off-flavor.

Studies on the effects of metals on oxidative flavor deterioration in dairy products have been focused particularly on milk, cream, butter, and dried milk. Archibald (1958a, b) made a detailed review on copper, iron, and other trace elements in milk and milk products. Little information is available, however, on (a) the quantities of copper and iron present in ice cream and mellorine, and (b) the possible significance of these metals in the development of oxidative flavor defects in ice cream and mellorine. Copper and iron may enter frozen desserts in dairy ingredients such as milk, cream, dried skim or dried whole milk, butter, butter oil, and concentrated milks; in non-dairy ingredients such as stabilizers, emulsifiers, sugars, fruits, and flavors; or through contamination from equipment and utensils. In ice cream the dairy ingredients are expected to contribute the major part of the copper and iron present. Pyenson and Tracy (1948), however, showed that some of the non-dairy ingredients may contain considerable quantities of metals that could be significant in the development of off-flavors in ice cream. Dahle and Folkers (1932) concluded from their studies that oxidative off-flavors in strawberry ice cream are due to a combined effect of copper and the acid of the fruit. No oxidative off-flavor was observed when the copper content of the sample was limited to 0.8 ppm. According to Ross (1933), iron did not seem important in the development of oxidized flavors in ice cream.

The test commonly used to detect lipid oxidation in dairy products, including ice cream and mellorine, consists of organoleptic examination of the product. Various terms such as metallic, oxidized, stale, cardboard, tallowy, and fishy have been used to describe oxidative defects in dairy products. In recent years various investigators (Biggs and Bryant, 1953; Inagaki *et al.*, 1954; Lockhart, 1953; Tanaka *et al.*, 1955; Wertheim and Proctor, 1956) have used the intensity of the red pigment formed in the reaction between 2-thiobarbituric acid (TBA) and malonaldehyde as an indirect measure of lipid oxidation in milk, cream, butter, cheese, condensed milk, and dried milk. The present study was initiated to determine (a) the levels of copper and iron in commercial samples of vanilla, strawberry, and chocolate ice cream and mellorine, and (b) the effect of various levels of these metals in commercial and experimental samples on the development of oxidative flavor defects. An attempt was also made to determine the relation between the levels of metals present in these frozen desserts, their TBA values, and the occurrence and intensity of oxidative flavor defects as determined by organoleptic examination.

EXPERIMENTAL METHODS

Source of samples. One hundred and seven samples were collected from 22 dairy processing plants in Texas. The flavors were limited to the three major types; vanilla, 23 ice creams and 15 mellorines; chocolate, 21 ice creams and 14 mellorines; strawberry, 20 ice creams and 14 mellorines. The samples were shipped from the various outlets to the laboratory packed in dry ice.

Preparation of glassware. In addition to normal laboratory cleaning procedures, all laboratory glassware used in the copper and iron determinations was immersed at least 5 min in hot nitric acid (1:4) at 60°C and then rinsed several times in double-distilled water. The distilled water was prepared in an all-glass distillation unit. All glassware was handled with Pyrex tongs that had been cleaned in a similar manner.

Determination of copper. Copper was determined by a procedure essentially like that described by King and Dunkley (1959). Color development with sodium diethyldithiocarbamate was carried out in a 60-ml ground-glass-stoppered glass bottle. Separation of the isoamyl acetate layer was obtained by centrifugation of the sample for 15 min in a 50% Babcock cream-test bottle in a Babcock centrifuge. After determination of optical density at 435 mμ with a Beckman DU Spectrophotometer, the copper concentration was determined from a standard curve as described by King and Dunkley.

Determination of iron. Iron was determined colorimetrically with 1,10-phenanthroline, essentially as reported by Pohle *et al.* (1947). Following ashing of the sample, 10 ml of a 1:10 solution of hydrochloric acid were added to the sample. It then was warmed gently on a hot plate to dissolve the ash completely. Hydroquinone, 1,10-phenanthroline, and sodium acetate were then added to the solution. The concentration of iron was determined from a standard curve as described by Pohle *et al.* Recovery experiments for copper and iron indicated respective recovery percentages of 92–110% and 90–115%.

Thiobarbituric acid test (TBA). Although various other procedures were tried, a modification of a steam-distillation TBA test for dried milk as reported by Sidwell *et al.* (1955) was used. A quantity of ice cream or mellorine equivalent to 4 g

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of fat was weighed out in a 250-ml extraction flask. An equal volume of distilled water was added and the sample was adjusted to pH 1.0–1.5 with 3*N* hydrochloric acid. The sample was then steam-distilled, and 50 ml of distillate was collected in 10 min. Steam-distillation was carried out as described by Vanderzant *et al.* (1961). The TBA value of the distillate, determined as described by Sidwell *et al.* (1955), was expressed as optical density at 530 mμ.

Preparation of ice cream with and without added copper or iron. Mixes were prepared in all-stainless-steel equipment. The composition of the mixes was as follows: 10% fat, 11% serum solids, 15% cane sugar, and 0.35% stabilizer. Milk, cream, low-heat non-fat dry milk solids, cane sugar, and stabilizer were used as ingredients. The mixes were combined and pasteurized 30 min at 155°F, and homogenized with a pressure of 1700 psi on the first and 500 psi on the second stage. They were then cooled in a plate cooler to 35–40°F, and stored at 40°F. The mixes, in two-gal. batches, were frozen in a batch freezer with an overrun of 70–80%. Mexican bean pure vanilla at a rate of 3.5 oz per 5 gal. of mix was used in all of the mixes. A strawberry puree was used in the strawberry ice cream, and a chocolate syrup for the chocolate ice cream. The ice cream was packaged in 1-qt and ½-gal. containers and stored at −25°C. Copper in the form of copper sulfate, and iron as ferrous and ferric sulfate, were added—to certain mixes before homogenization, and to others after cooling of the mixes just before freezing. The addition of copper before homogenization was accomplished as follows: Immediately after pasteurization the mix was divided into 5-gal. batches, and varying amounts of copper were added to these batches. These batches were then homogenized, starting with the mix of the lowest copper concentration. Slight variations from the calculated metal content due to some mixing of the various batches were not important since copper and iron determinations were made on each batch after freezing. The addition of metals after cooling of the mixes did not present any problem.

Organoleptic examination. All samples of ice cream and mellorine were examined for oxidative flavor defects by at least two judges.

EXPERIMENTAL RESULTS

Factors affecting steam-distillation TBA values. The effect of pH of reaction mixture, distillation, and heating time on the intensity of TBA pigment was investigated. Without lowering the pH, little or no TBA reactive compounds were freed by distillation. Normal and oxidized samples of ice cream were used and reacted with the TBA reagent for 35 min at pH levels ranging from 0.5 to 3.0. Only small differences in color intensity were observed at the various pH levels of the ice cream–hydrochloric acid mixture. The length of heating of the combined distillate-TBA solution had a pronounced effect on the intensity of the developed color in the oxidized sample, but little on that of the unoxidized sample (Table 1). A variation in the pH value of the ice cream–hydrochloric acid mixture from 0.5 to 1.0 had little effect on the intensity of the color after heating for various periods. An increase in distillation time from 10 to 30 min to collect 50 ml of distillate did not cause significant changes in the TBA values of the sample. The absorption spectrum of the TBA pigment of the steam-distillate from a sample of metallic ice cream showed a single maximum at 530 mμ. In addition to this procedure, various other TBA procedures and modifications were tried on oxidized and unoxidized samples of ice cream and on the fats isolated from these products. Sidwell's straight-fat TBA test (Sidwell *et al.*, 1954) showed much higher values when the fat was heated in a boiling water bath for 1 hr before being heated with TBA reagent. The Giroux method (Giroux *et al.*, 1955) and Patton's reflux method (Patton and Kurtz, 1951) were tried, but the results were not as consistent as with the method described by Sidwell *et al.* (1955). In subsequent TBA tests 50 ml of distillate were removed in 10 min from the samples at pH 1.0–1.5. Color was developed by heating the distillate 35 min with the TBA reagent in a boiling water bath.

Table 1. Effect of time of heating distillate with TBA at 100°C upon intensity of TBA pigment (OD).

Sample no.	pH	Heating time (min)			
		10	20	30	40
1 (normal)	1.0	.029	.030	.037	.041
	0.5	.024	.032	.041	.046
2 (oxidized)	1.0	.076	.132	.147	.179
	0.5	.076	.137	.164	.177

Copper and iron content of commercial samples of ice cream and mellorine. Figs. 1, 2, 3, and 4 present data on the copper and iron contents of 107 samples of vanilla, chocolate, and strawberry ice cream and mellorine. The levels of copper in the various products ranged as follows: vanilla ice cream, 0.1–0.87; vanilla mellorine, 0.115–0.970; chocolate ice cream, 0.33–3.37; chocolate mellorine, 0.73–2.17; strawberry ice cream, 0.085–1.415; and strawberry mellorine, 0.13–1.37 ppm. The mean copper contents for the various products were: vanilla ice cream, 0.304; vanilla mellorine, 0.306; chocolate ice cream, 1.247; chocolate mellorine, 1.074; strawberry ice cream, 0.422; strawberry mellorine, 0.358; all ice creams combined, 0.650; all mellorines combined, 0.573 ppm. The levels of iron in the various products ranged as follows: vanilla ice cream, 0.375–1.875; vanilla mellorine, 0.375–0.925; chocolate ice cream, 1.45–5.0; chocolate mellorine, 1.75 to over 5.0; strawberry ice cream, 0.725 to over 5.0; strawberry mellorine, 0.350–3.925 ppm. The mean iron contents for vanilla, chocolate, and strawberry ice cream were 0.822, 2.954, and 1.480 ppm; for the vanilla, chocolate, and strawberry mellorines, 0.572, 2.803, and 1.184 ppm, respectively.

Relationship between copper and iron content and TBA values. The data in Tables 2 and 3 show fairly high positive correlations between (a) the copper contents of chocolate, strawberry, or total ice cream and their TBA values and (b) the iron contents of strawberry ice cream, strawberry mellorine, or total ice cream and their TBA values. A fairly high negative correlation was observed between the copper contents of the vanilla mellorines or the iron content of the vanilla ice creams and their respective TBA values.

Relationship between copper or iron content, TBA values, and flavor defect. Twenty-two percent of the vanilla ice creams, 13% of the vanilla mellorines, 10% of the chocolate ice creams, 20% of the strawberry ice creams, and none of the chocolate and strawberry mellorines were criticized for definite oxidative flavor defects. Table 4 lists the various flavor defects observed in the vanilla ice creams and mellorines. No definite relation

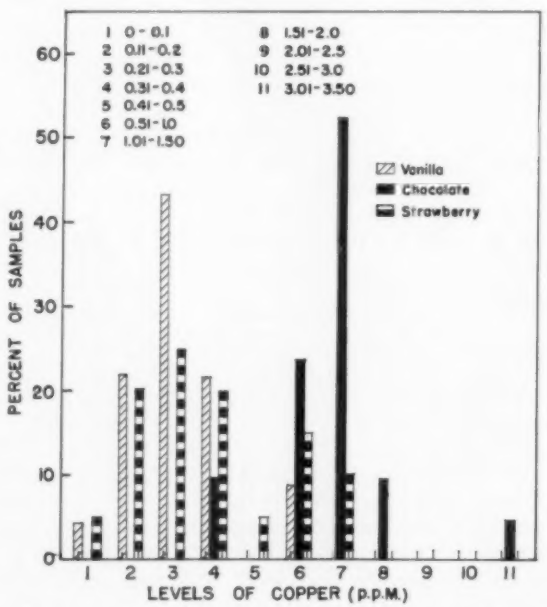

Fig. 1. Concentration of copper in vanilla, chocolate, and strawberry ice creams.

Table 2. Statistical analysis of relation between copper content and TBA test in various frozen desserts.

Frozen dessert	n	$\bar{x}$ [a]	$\bar{y}$ [b]	r	b
Vanilla ice cream	23	.304	.024	.002	.0001
Vanilla mellorine	15	.306	.029	—.623	—.032
Chocolate ice cream	21	1.247	.077	.293	.011
Chocolate mellorine	14	1.074	.092	.079	.005
Strawberry ice cream	20	.422	.034	.235	.011
Strawberry mellorine	14	.358	.033	—.020	—.001
Total ice cream	64	.650	.044	.259	.011
Total mellorine	43	.573	.051	—.055	—.003

[a] Copper ppm.
[b] Optical density (TBA).

Table 3. Statistical analysis of relation between iron content and TBA test in various frozen desserts.

Frozen dessert	n	$\bar{x}$ [a]	$\bar{y}$ [b]	r	b
Vanilla ice cream	23	.822	.024	—.456	—.010
Vanilla mellorine	15	.572	.029	—.117	—.008
Chocolate ice cream	21	2.954	.077	.148	.003
Chocolate mellorine	14	2.803	.092	—.035	—.001
Strawberry ice cream	20	1.480	.034	.583	.010
Strawberry mellorine	14	1.184	.033	.495	.010
Total ice cream	64	1.727	.044	.247	.005
Total mellorine	43	1.497	.051	.156	.004

[a] Iron ppm.
[b] Optical density (TBA).

could be established between oxidative flavor defects in the vanilla-flavored samples (Tables 5, 6) and the metal content or TBA values of the samples. Some samples with non-oxidative flavor defects had copper or iron contents or TBA values comparable to or higher an those with oxidative flavor defects. A similar pattern existed for the strawberry and chocolate samples. Of the two vanilla ice cream samples with a copper content in the range of 0.5–1 ppm, one was criticized as oxidized (0.545 ppm) and the other as custard-like (0.87 ppm).

Effect of added copper and iron on oxidative flavor defects. Eight batches of ice cream were prepared with various amounts

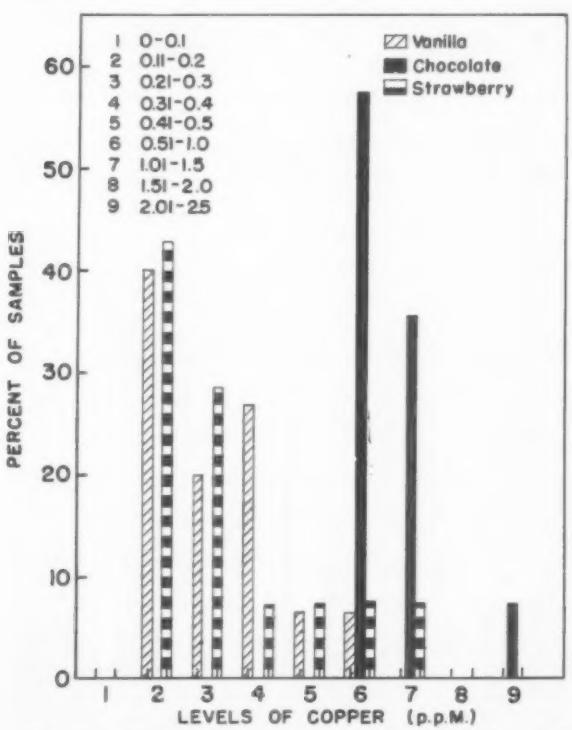

Fig. 2. Concentration of copper in vanilla, chocolate, and strawberry mellorines.

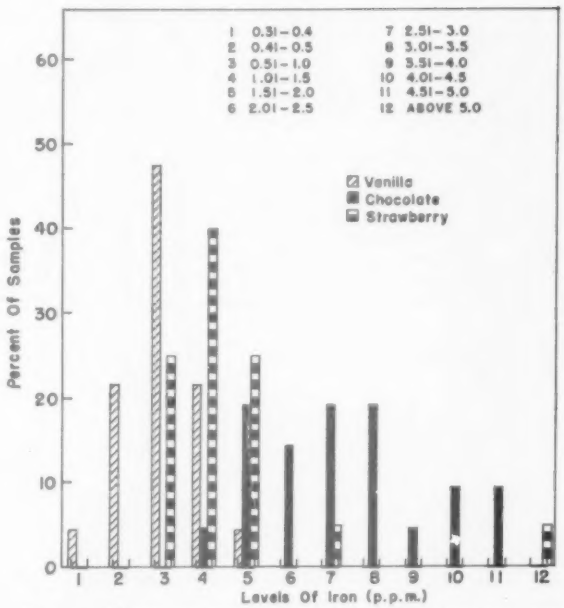

Fig. 3. Concentration of iron in vanilla, chocolate, and strawberry ice creams.

of copper added following homogenization. After one day of storage a metallic flavor was detectable in the ice cream with 2.94 ppm of added copper (Table 7). This defect was more intense with the concentration of added copper. After 11 days of storage a metallic off-flavor was noticeable in ice cream with 0.82 ppm of added copper. After storage for 106 days a fishy flavor developed in the samples with 2.94 ppm or more of added copper. The data in Table 8 also show that homogenization had a pronounced effect on the rate of development of copper-induced oxidized flavor in ice cream. Copper added (4.56 ppm) before homogenization failed to show a metallic off-flavor until after 25 days of storage. However, with the same amount or even less (1.92 ppm) copper added after homogenization a metallic off-flavor developed after 9 days of storage. After 80 days of storage a fishy flavor was noticeable in the sample with 4.56 ppm of copper added after homogenization.

Iron added after homogenization up to 10.5 Fe^{++} and 20.93 Fe^{+++} ppm failed to show development of an oxidative flavor defect even at the end of 106 days of storage.

Rate of development of oxidized flavor defects. The data in Table 9 indicate that, with approx 2 ppm of added copper, a metallic flavor developed in four days in vanilla and strawberry ice cream, but not in chocolate ice cream. With about 1 ppm, a metallic flavor was noticeable after 21 or 46 days in

Table 4. Flavor criticisms [a] of samples of vanilla ice cream and mellorine.

Defect	Percent of samples	
	Vanilla ice cream	Vanilla mellorine
Bitter	....	6.7
Cooked	13.1	....
Custard	4.4	....
Fruity	4.4	....
Lacks fine flavor	4.4	....
Old ingredient	8.7	6.7
Oily	....	6.7
Oxidized	8.7	....
Rancid	13.1	....
Salty	....	13.3
Stale	4.4	6.7
Too sweet	17.4	....
Unnatural flavor	21.8	46.6
No criticism	....	13.3

[a] With two or more criticisms per sample only the major criticism was listed.

Table 5. Relation between copper content, iron content, and TBA test of vanilla ice cream and flavor criticisms.

	Number of samples									
	Cooked	Custard	Fruity	Lacks fine flavor	Old ingr.	Oxid.	Rancid	Stale	Too sweet	Unnat. flavor
Ranges of copper (ppm)										
0– .1	—	—	—	1	—	—	—	—	—	—
.11– .2	—	—	—	—	1	—	1	—	2	1
.21– .3	1	—	1	—	1	1	1	1	2	2
.31– .4	2	—	—	—	—	—	1	—	—	2
.41– .5	—	—	—	—	—	—	—	—	—	—
.51–1.0	—	1	—	—	—	1	—	—	—	—
Ranges of iron (ppm)										
.31– .4	—	—	—	—	—	—	—	—	—	1
.41– .5	1	—	—	1	1	1	—	—	1	—
.51–1.0	2	1	—	—	1	1	1	—	1	4
1.01–1.5	—	—	1	—	—	—	1	1	2	—
1.51–2.0	—	—	—	—	—	—	1	—	—	—
TBA (OD)										
0–.01	—	—	—	—	—	—	1	—	—	—
.0101–.015	—	—	—	—	—	—	1	1	—	—
.0151–.020	1	—	—	—	—	1	—	—	—	2
.0201–.0250	1	—	—	1	—	—	1	—	—	1
.0251–.0300	—	1	—	—	—	1	—	—	2	2
.0301–.0350	1	—	—	—	1	—	—	—	2	—
.0351–.0400	—	—	—	—	1	—	—	—	—	—

the vanilla ice cream, but not in the chocolate or strawberry ice cream. When double-pasteurized cream was used, added copper of 1–2 ppm did not result in a metallic flavor in vanilla, chocolate, or strawberry ice cream even at the end of 46 days of storage.

Effect of length of storage on TBA values. The data in Fig. 5 indicate that samples with copper added in the range of 0–1.92 ppm before or after homogenization showed some increase in the TBA values after 80 days of storage. At these levels of added copper little difference in TBA values was noted in the samples with the copper added before or after homogenization. Initial TBA values of all samples were very similar. TBA value increased markedly after 40 days of storage in the fishy sample to which 4.56 ppm of copper was added. A similar pattern was noticed in the samples described in Tables 7 and 9. The more pronounced the oxidative flavor defect the greater was the increase in the TBA value.

TBA values were also determined on the flavoring materials of vanilla, chocolate, and strawberry samples used in this study. The amounts used in the distillation procedure were comparable to those usually present in an amount of ice cream containing 4 g of fat. The respective TBA values of vanilla, chocolate, strawberry extract, and strawberry extract plus puree were 0.010, 0.070, 0.034, and 0.032.

Table 6. Relation between copper content, iron content, and TBA test of vanilla mellorine and flavor criticisms.

	Number of samples					
	Bitter	Old ingr.	Oily	Salty	Stale	Unnat. flavor
Ranges of copper (ppm)						
0– .1	—	—	—	—	—	—
.11– .2	—	—	—	1	1	4
.21– .3	1	—	—	—	—	2
.31– .4	—	1	1	1	—	—
.41– .5	—	—	—	—	—	—
.51–1.0	—	—	—	—	—	1
Ranges of iron (ppm)						
.31– .4	1	—	—	—	1	3
.41– .5	—	—	1	—	—	—
.51–1.0	—	1	—	2	—	4
1.01–1.5	—	—	—	—	—	—
1.51–2.0	—	—	—	—	—	—
TBA (OD)						
0–.01	—	—	—	—	—	—
.0101–.0150	—	—	—	—	—	—
.0151–.0200	—	—	—	—	—	1
.0201–.0250	1	—	1	—	—	1
.0251–.0300	—	—	—	—	—	2
.0301–.0350	—	1	—	1	—	—
.0351–.0400	—	—	—	—	—	2
.0401–.0500	—	—	—	1	1	1

The length of the storage period had little effect on TBA value when various levels of iron (0–20.93 ppm) were added after homogenization.

DISCUSSION AND CONCLUSIONS

The effects of pH, distillation, and heating time on the intensity of the TBA pigment were essentially the same as reported by Sidwell *et al.* (1955). The high copper and iron values in the chocolate-flavored samples were not surprising. Pyenson and Tracy (1948) reported rather large quantities of copper and iron in various cocoas. Although the copper content of the majority of the strawberry samples was very similar to that of the vanilla-flavored samples, iron values were higher in strawberry than in vanilla samples. This observation agrees with data on an analysis of berries showing that the iron content is much greater

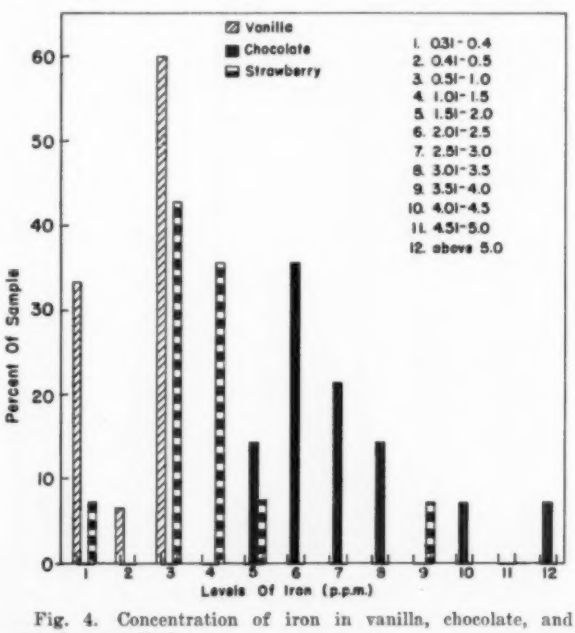

Fig. 4. Concentration of iron in vanilla, chocolate, and strawberry mellorines.

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Table 7. Effect of adding copper after homogenization on the development of metallic flavor and TBA values in vanilla ice cream.

Storage time (days)	Concentration of copper[a] (ppm)							
	0	0.03	0.33	0.82	1.69	2.94	9.68	16.56
	Flavor defects							
1	—[b]	—	—	—	±	+	++	+++
11	—	—	—	+	+	++	+++	++++
21	—	—	—	+	+	++	+++	++++
35	—	—	—	+	+	++	+++	++++
51	—	—	±	+	+	++	+++	++++
78	—	—	±	+	+	++	+++	++++
106	—	—	±	+	++	*[c]	*	*
	TBA values after 106 days							
	0.083	0.082	0.093	0.093	0.139	0.221	0.434	0.673

[a] Copper added following homogenization; 0.6 ppm natural copper present.
[b] Metallic flavor (— absent, ± doubtful, + v. slight, ++ slight, +++ strong, ++++ v. strong).
[c] Fishy.

than the copper content (Jacobs, 1944). The strawberry puree used in our laboratory contained 2.25 ppm of iron and 0.25 ppm of copper. The copper content of the ice cream or mellorine was related to TBA values somewhat more definitely than was the iron content. Correlations between copper content and TBA value were positive for the three groups of ice cream, and negative for the majority of the mellorine samples. Perhaps this may be due to a difference in the type of fats used. In mellorine, hydrogenated fats are commonly used, whereas in ice cream, milk fat with unsaturated fatty acids and phospholipids is used. Sidwell *et al.* (1954) also reported that fats of low linolenic acid content had induction periods when the oxidation was followed with the TBA test. No definite relation could be established between oxidative flavor defects in the commercial samples of ice cream and mellorine on the basis of organoleptic examination and copper content. Although the data on the commercial samples are limited, there may be some indication that in certain samples oxidative flavor defects are accompanied by fairly high TBA values. In this respect it is interesting to note that: (a) the two samples of vanilla ice cream with the highest TBA values (0.036 and 0.035) among the vanilla ice creams (range 0.009–0.036) were both criticized for "old ingredient"; and (b) two vanilla mellorines, one criticized for "old ingredient" and the other for "stale," had respective TBA values of 0.031 and 0.046 (range 0.012–0.046). It is recognized that some other samples without oxidative flavor defects had similar TBA values. The possibility exists that other flavor defects may mask the early phases of oxidative flavor defects. Subsequent studies with experimental samples have shown that the TBA values of ice creams have to be considerably higher than those found in the commercial samples to be called metallic or fishy. The results of one series of experiments indicate that 0.82 ppm of copper added after homogenization caused a metallic flavor in vanilla ice cream after 11 days of storage at −25°C. When copper was added before homogenization the rate of development of a metallic flavor was much slower. Changes in the fat globule surface, most likely, are responsible for this observation. Homogenization increases the surface area per gram of fat and decreases the concentration per unit of fat-globule surface area of the components involved in the oxidation process (Tarassuk and Koops, 1960). Hence, it is obvious that the rate of development of a metallic flavor at a certain level of copper depends greatly on the manner in which the mix was contaminated. Double pasteurization of the cream used in the ice cream mix delayed development of a metallic flavor. It is generally known that high heat treatment activates substances that are anti-oxygenic. Furthermore, heat also causes marked changes in the chemical nature of the materials adsorbed on the milk fat globule (Loewenstein, 1960). This in turn may affect the oxidation process.

The results of one series of experiments indicate that a metallic off-flavor was noticeable at a lower concentration of copper in vanilla than in strawberry or chocolate ice cream. This observation with strawberry ice cream agrees with that of Ross (1933), who reported that these off-flavors developed sooner in the control samples than in the companion strawberry samples. This kind of flavor defect may be covered up by the flavoring materials used. The same may be true for the chocolate ice cream. Furthermore chocolate ice cream is somewhat protected by the tannins, which act as antioxidants (Schricker, 1935). Data on the effect of length of storage on the TBA value of vanilla ice cream indicate that a very slight metallic flavor was noticeable at a TBA value of about 0.09, a slight metallic flavor in the range 0.09–0.139, and a

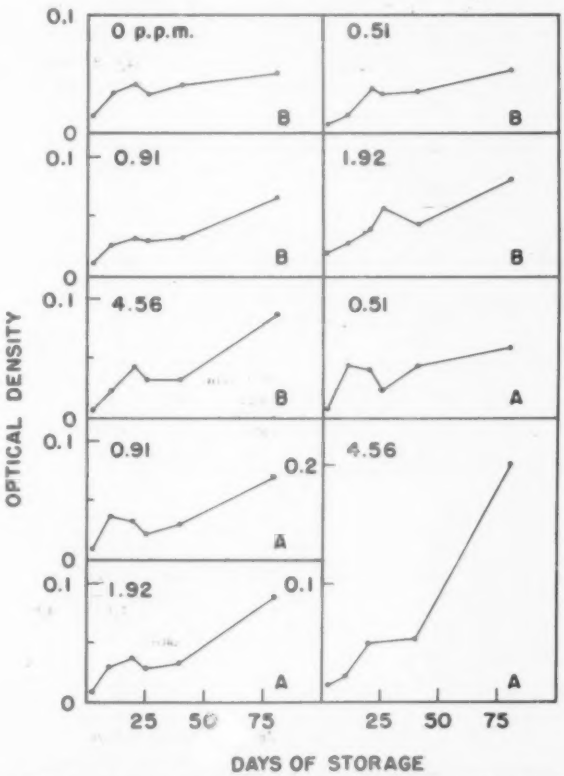

Fig. 5. Effect of length of storage of ice cream without and with copper added before (B) and after (A) homogenization on the intensity of the TBA pigment.

Table 8. Effect of adding copper before and after homogenization on the development of metallic flavor in vanilla ice cream.

Storage time (days)	Concentration of copper (ppm)[a]				
	0	0.51	0.91	1.92	4.56
Copper added before homogenization					
1	—[b]	—	—	—	—
9	—	—	—	—	±
25	—	—	—	—	+
52	—	—	—	—	+
80	—	—	—	±	+
Copper added after homogenization					
1	—	—	—	—	±
9	—	—	—	+	++
25	—	—	±	+	+++
52	—	—	+	++	+++
80	—	—	+	++	[c]

[a] 0.42 ppm natural copper present.
[b] Metallic flavor (— absent, ± doubtful, + v. slight, ++ slight, +++ strong, ++++ v. strong).
[c] Fishy.

fishy flavor at a TBA value of about 0.221. These results with vanilla ice cream agree very well with those on dried milks reported by Sidwell *et al.* (1955). Those workers reported TBA values of 0.188 and 0.256 for badly oxidized dried milks. The highest TBA value was 0.036 for the commercial vanilla ice creams, and 0.046 for the mellorines. Both samples were criticized for oxidative flavor defects (old ingredient, stale). Although the data in this study are limited, the results seem to indicate that some oxidative flavor defects are detected by taste before they can be detected by this TBA procedure. The higher TBA values for the chocolate and strawberry samples are in part due to steam-volatile materials that react with the TBA reagent. The present study also indicates that all commercial samples contained less copper than the lowest concentration necessary to initiate oxidative flavor defects in the experimental samples within the limits of the storage periods used in these experiments.

Table 9. Effect of adding copper on the development of metallic flavor and TBA values in vanilla, chocolate, and strawberry ice cream.

Ice cream flavor	Storage time (days)	Concentration of copper (ppm)[a]				
		0	0.56	0.95	2.21	4.76
		Flavor defects				
Vanilla	1	—[b]	—	—	—	±
	4	—	—	—	+	++
	21	—	—	+	+	++
	46	—	—	+	+	++
		TBA values after 46 days				
		.068	.090	.091	.089	.109
		0	0.39	1.01	2.19	5.11
		Flavor defects				
Chocolate	1	—	—	—	—	±
	4	—	—	—	—	±
	21	—	—	—	—	—
	46	—	—	—	—	±
		TBA values after 46 days				
		.081	.109	.101	.123	.125
		0	0.42	0.89	1.83	4.82
		Flavor defects				
Strawberry	1	—	—	—	—	±
	4	—	—	—	+	±
	21	—	—	—	+	+
	46	—	—	—	+	+
		TBA values after 46 days				
		.069	.077	.084	.106	.153

[a] Copper added following homogenization, the natural copper contents (mix and flavor) of the vanilla, chocolate, and strawberry mixes were respectively 0.30, 0.38, and 0.33.
[b] Metallic flavor (— absent, ± doubtful, + v. slight, ++ slight).

REFERENCES

Archibald, J. G. 1958a. Trace elements in milk—review. I. *Dairy Sci. Abstr.* **20**, 711.

Archibald, J. G. 1958b. Trace elements in milk—review. II. *Dairy Sci. Abstr.* **20**, 801.

Biggs, D. A., and L. R. Bryant. 1953. The thiobarbituric acid test for butterfat oxidation. *Can. J. Technol.* **31**, 138.

Dahle, C. D., and E. C. Folkers. 1932. How can we control the off-flavor appearing in strawberry ice cream. *Ice Cream Trade J.* **28**, 37.

Giroux, R. N., L. R. Bryant, and W. H. Sproule. 1955. Quality and iron contamination of dairy products and thiobarbituric acid test. Part II of a study of the effect on quality of dairy products of various types of milk cans. *Can. Dairy Ice Cream J.* **34**, 44.

Inagaki, C., K. Tarao, and M. Fujimaki. 1954. Studies on the reaction of thiobarbituric acid (TBA) with fat in foods. 2. Reaction TBA with oxidized milk fat. *J. Agr. Chem. Soc. Japan.* **28**, 967.

Jacobs, M. B. 1944. The chemistry and technology of food and food products. Vol. **1**, 763. Interscience Publishers Inc., New York, New York.

King, R. L., and W. L. Dunkley. 1959. Relation of natural copper in milk to incidence of spontaneous oxidized flavor. *J. Dairy Sci.* **42**, 420.

Lockhart, E. E. 1953. Application of the thiobarbituric acid test in a study on the development of oxidized flavor in milk. *Conv. Proc.* Milk Ind. Foundation, p. 33.

Loewenstein, M. 1960. The effect of heat on the chemical nature of the materials adsorbed on the milk fat globule. *Dissertation Abstr.* **20**, 3051.

Patton, S., and G. W. Kurtz. 1951. 2-thiobarbituric acid as a reagent for detecting milk fat oxidation. *J. Dairy Sci.* **34**, 669.

Pohle, W. D., J. H. Cook, and V. C. Mehlenbacher. 1947. Determination of iron in food and food products. *Food Research.* **12**, 229.

Pyenson, H., and P. H. Tracy. 1948. Iron and copper content of non-milk products commonly used in ice cream. *J. Dairy Sci.* **31**, 269.

Ross, O. E. 1933. Why does a tallowy flavor develop in strawberry ice cream? *Ice Cream Trade J.* **29**, 23.

Schricker, A. C. 1935. The effect on quality of the age of the package. *Ice Cream Field.* **26**, 18.

Sidwell, C. G., H. Salwin, M. Benca, and J. H. Mitchell. 1954. The use of thiobarbituric acid as a measure of fat oxidation. *J. Am. Oil Chemists' Soc.* **31**, 603.

Sidwell, C. G., H. Salwin, and J. H. Mitchell, Jr. 1955. Measurement of oxidation in dried milk products with thiobarbituric acid. *J. Am. Oil Chemists' Soc.* **32**, 13.

Tanaka, S., K. Kuriiwa, and H. Ikegami. 1955. Studies on the estimation of oxidized flavor index in milk and milk products with 2-thiobarbituric acid (TBA) reagent. I. Adaptation of TBA method to the estimation of oxidized flavor in milk and whole milk powder. *Jap. J. Zootech. Sci.* **26**, 63.

Tarassuk, N. P., and J. Koops. 1960. Inhibition of oxidized flavor in homogenized milk as related to the concentration of copper and phospholipids per unit of fat globule surface. *J. Dairy Sci.* **43**, 93.

Vanderzant, C., M. A. Brown, and I. W. Rupel. 1961. Determination of the protein content of milk by a modification of the steam distillation method of Kofranyi. *J. Milk Food Technol.* **24**, 19.

Wertheim, J. H., and B. E. Proctor. 1956. Radiation preservation of milk and milk products. III. The thiobarbituric acid test as a means of evaluating radiation-induced changes in milk. *J. Dairy Sci.* **39**, 391.

Spectrophotometric Evaluation of Anthocyanin Pigment Development and Scald Damage in Intact Red Tart Cherries[a]

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(Manuscript received May 9, 1961)

SUMMARY

The light-transmittance properties of intact cherries were measured with three new instruments. Optical density differences (△OD) between selected pairs of wavelengths in the region *ca.* 450–800 mμ were explored for indicating scald damage and anthocyanin pigment development. An index of damage, △OD 780–695, is suggested as a good measurement of the scald damage in bruised fruit. This damage was particularly severe in bruised fruit held so that the cherries touched one another, at room temperature (80°F) and in sunlight (90°F plus). The correlation (.83) between anthocyanin content of individual sound cherries and △OD 540–612 was highly significant. A system for intact cherry spectrophotometry should first sort out scalded cherries by △OD 780–695 and then measure the color of individual sound fruit by △OD 540–612.

The color of red tart cherries *(Prunus cerasus* L.) is an important quality factor, readily observable by the consumer, and thus a significant influence on the value of the product (Wagenknecht *et al.*, 1960). Hence, color is a factor of grade in the U. S. Standards for Red Sour Cherries for Manufacture (Anon., 1946) as well as in Standards applying to canned and frozen cherries (Anon., 1949a, b). These standards are applied by visual evaluation, using such descriptive terminology as "fairly well colored" (Anon., 1946) and "good, bright typical color" (1949a). Objective methods are desired (Floate, 1960), and some research has been done toward their development. Measurement of the concentration of the anthocyanin pigments responsible for the typical red color of cherries has been suggested. The methods suggested, however, require extraction of pigments from a sample with suitable solvents, followed by spectrophotometry of the extract.

This paper reports research on the newer method of intact fruit spectrophotometry for evaluation of anthocyanin pigment development, and also scald damage, which appeared as a complicating factor as the research progressed.

EXPERIMENTAL METHODS

Cherries. The fruit were obtained from the C. H. Musselman Company, Biglerville, Pa., either from their orchards or from lug boxes or holding tanks at their processing plant. Cherries obtained from the orchards were always cut from the stem to avoid bruising.

A distribution of cherries of different anthocyanin contents was secured for some of the exploratory tests by selecting fruit showing more or less red color on the trees, in the delivery lug boxes, or in holding tanks. A distribution of maturities was established during the 1960 season by periodic harvesting of cherries that had been tagged at blossom time, April 12. Three classes were tagged: 1) full bloom (F); 2) pre-full bloom (P); and 3) after full bloom (A).

Intact-fruit spectrophotometers. Instruments were the Rephobiospect (Birth *et al.*, 1957), the Hortispect (Birth and Norris, 1958), equipped with a strip-chart recorder, and a two-filter optical-density difference meter hereinafter referred to as ODDM, originally built for smut determination in wheat (Birth, 1960), but modified for cherries. The first two instruments read directly in optical-density increments; the third on a scale reading in optical-density differences, i.e., the difference between OD at 780 mμ and OD at 695 mμ, or ΔOD 780–695. Relationships between light-transmittance characteristics and chemical composition are best shown by calculating differences in optical densities between selected pairs of wavelengths ΔOD $(\lambda_1 - \lambda_2)$ (Birth *et al.*, 1957; Sidwell *et al.*, 1961).

The intact fruits were placed in the instrument examination holders with the stems up when the readings were taken.

Anthocyanin determinations. Anthocyanin content of individual cherries was determined. Each pitted cherry was weighed, placed in 25–50 ml 1% HCl-acidified-methanol solution, and extracted 3 min in a Virtis "45" Homogenizer operated at *ca.* 45,000 rpm. (Mention of commercial instruments and manufacturers is for identification only, and does not constitute endorsement or recommendation by the United States Department of Agriculture.) The extract was filtered, and the filtrate made up to 100 ml and read on the IDL-Color Eye instrument at 533 mμ. OD was divided by the pitted weight to furnish a relative value corrected for fruit size.

Soluble solids. Soluble solids content of the juice of individual cherries was determined with a hand-refractometer.

Artificial induction of scald. For induced-scald experiments the cherries were bruised, either by rubbing between the fingers or by dropping 18 in. on a ½-in. aluminum plate, then held various times in shade or sunlight, and at various temperatures, in or out of water. On the last three of the four dates at which these experiments were run, the cherries were held in contact with each other, the technique being copied from previous workers (Hills *et al.*, 1953; LaBelle *et al.*, 1958).

Subjective evaluation of scald. Surface development of scald was estimated on a scale from 0 (none) to 10 (100% of surface scalded). Internal scald development was estimated according to a similar scale in which the increasing cloudiness and browning of the tissues were scored from 0 to 10.

Canning test and objective evaluation of color of canned product. In a single canning test the cherry samples were washed, pitted, and filled into No. 303 enameled cans in water. Exhausting, closing, and processing were done according to the technique of the cooperating cannery. Color was measured objectively with the Gardner Color and Color Difference Meter, which had been standardized on a dark-red tile standard bearing the specifications $L = 24.3$, $a_L = 20.9$, $b_L = 6.0$. The contents of each can were poured into a special glass-bottom cup for viewing on the instrument; three readings were recorded and averaged.

[a] Presented at the 21st Annual Meeting of the Institute of Food Technologists, New York, May 7–11, 1961.

[b] Present address: Giant Foods, Inc., Landover, Md.

Statistical methods. Analysis of variance and calculations of correlation coefficients were according to Snedecor (1940).

RESULTS AND DISCUSSION

Estimation of anthocyanin content of sound cherries (1959 harvest). The shapes of light-transmittance curves drawn from intact, sound cherries by use of the Hortispect were related to their stages of maturity and anthocyanin contents. The most noticeable change in these curves in the spectral region *ca.* 445–750 mμ was below 620 mμ, where increased absorbance was associated with advancing maturity and increasing anthocyanin content. The curves in Fig. 1 show four

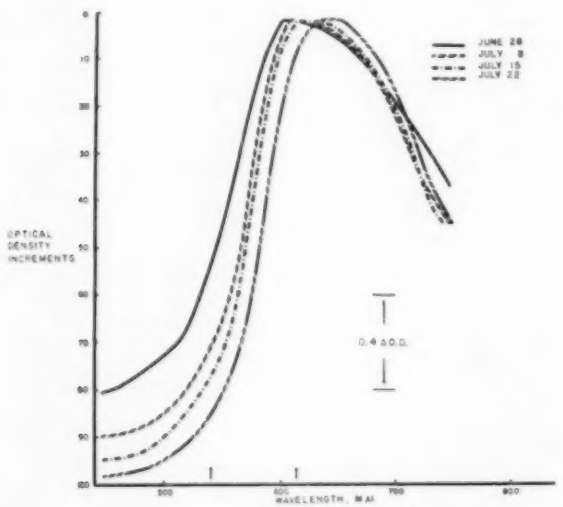

Fig. 1. Hortispect curves of intact sound cherries showing increased absorption at shorter wavelengths with advancing maturity.

stages of this change and are actual tracings from recordings of individual cherries at the dates given. Changes were first indicated by optical-density increments readings taken at three wavelengths (590, 620, 670 mμ) on the Rephobiospect on a 12-unit sample of cherries selected to provide a range of color (Table 1).

Table 1. Effect of red cherry color on light-transmittance characteristics of intact sound fruit.

Individual color rank[c]	Optical density as percent full scale[a, b]			Optical-density difference (ΔOD)		
	590 mμ	620 mμ	670 mμ	590–620 mμ	670–620 mμ	750–670 mμ
12	31.9	24.1	28.8	7.8	4.7	31.2
11	34.2	25.4	29.6	8.8	4.2	30.4
10	36.8	25.8	29.2	11.0	3.4	30.8
9	40.8	27.9	29.1	12.9	1.2	30.9
8	37.2	26.5	29.1	10.7	2.6	30.9
7	40.6	26.9	29.3	13.7	2.4	30.7
6	34.5	24.9	28.5	9.6	3.6	31.5
5	39.0	26.8	28.7	12.2	1.9	31.3
4	53.4	32.9	30.0	20.5	−2.9	30.0
3	49.6	31.9	29.9	17.7	−2.0	30.1
2	55.5	33.4	30.0	22.1	−3.4	30.0
1	66.1	38.2	31.0	27.9	−7.2	29.0

[a] Full-scale sensitivity = 4.0 OD.
[b] Recorder adjusted to constant value of 60.0 at 750 mμ, making readings at specified wavelengths comparable.
[c] 12, least-red color, to 1, most-red color, by visual ranking.

OD differences, ΔOD 590–620 and ΔOD 670–620, progressive with color development in the 12-unit sample, are shown. The ΔOD 750–670 was insensitive to pigment development and was not used for this type of measurement.

The OD of intact fruit or other intact units of produce, at any wavelength of energy, is affected by unit size and other factors such as changes in light intensity in the instrument. Compensation for size effect improves correlations in most cases. The wavelength of peak transmittance, which is read directly from the Hortispect instrument, also provides useful information about internal color changes and maturity (Ernest *et al.*, 1958).

OD difference readings taken on several samples of cherries during the 1959 harvest season were compared with the extracted anthocyanin contents of the individual cherries. In this exploratory work the relationship between anthocyanin contents and ΔOD 590–620 was highly significant.

A test was also conducted to determine the color of the processed product that would result from canning cherries classified for anthocyanin content on the basis of ΔOD 590–620. Cherries from lug-box deliveries were classified by meter reading into five categories based on ΔOD 590–620 values using the ODDM (Birth, 1960), and each class was canned separately. Visually, these classes of raw cherries varied from poor color to good red color. After several months' storage at *ca.* 75°F the cans were opened and the samples compared, visually and by objective readings. The canned cherries originally classified by meter readings associated with good red color were darker and of less saturated red hue than the ones classified as poor color, which were lighter and of more saturated hue, shifting toward the yellow-red (Fig. 2, Table 2).

A comparison of the classified cherries, after canning, with two commercial samples of canned cherries indicated that classes 3 and 4 of the experimental lots were about the same color as the commercial samples (Table 2), based on a_L/b_L values.

Evaluation of bruised and scalded cherries (1959 harvest). Scald damage induced by bruising, followed by holding, is frequently a cause of poor quality (Hills

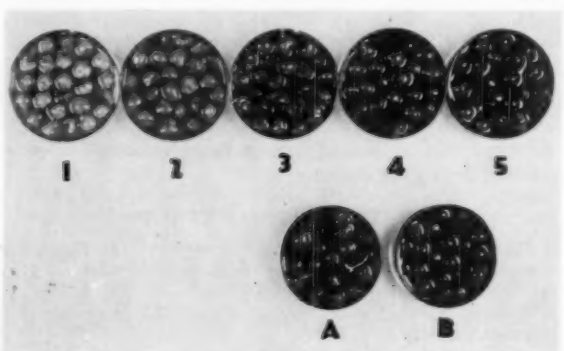

Fig. 2. Red tart cherries classified by ΔOD 590–620 values, processed and stored 3 months at *ca.* 75°F. 1 = least red, to 5 = most red; A and B are commercial samples.

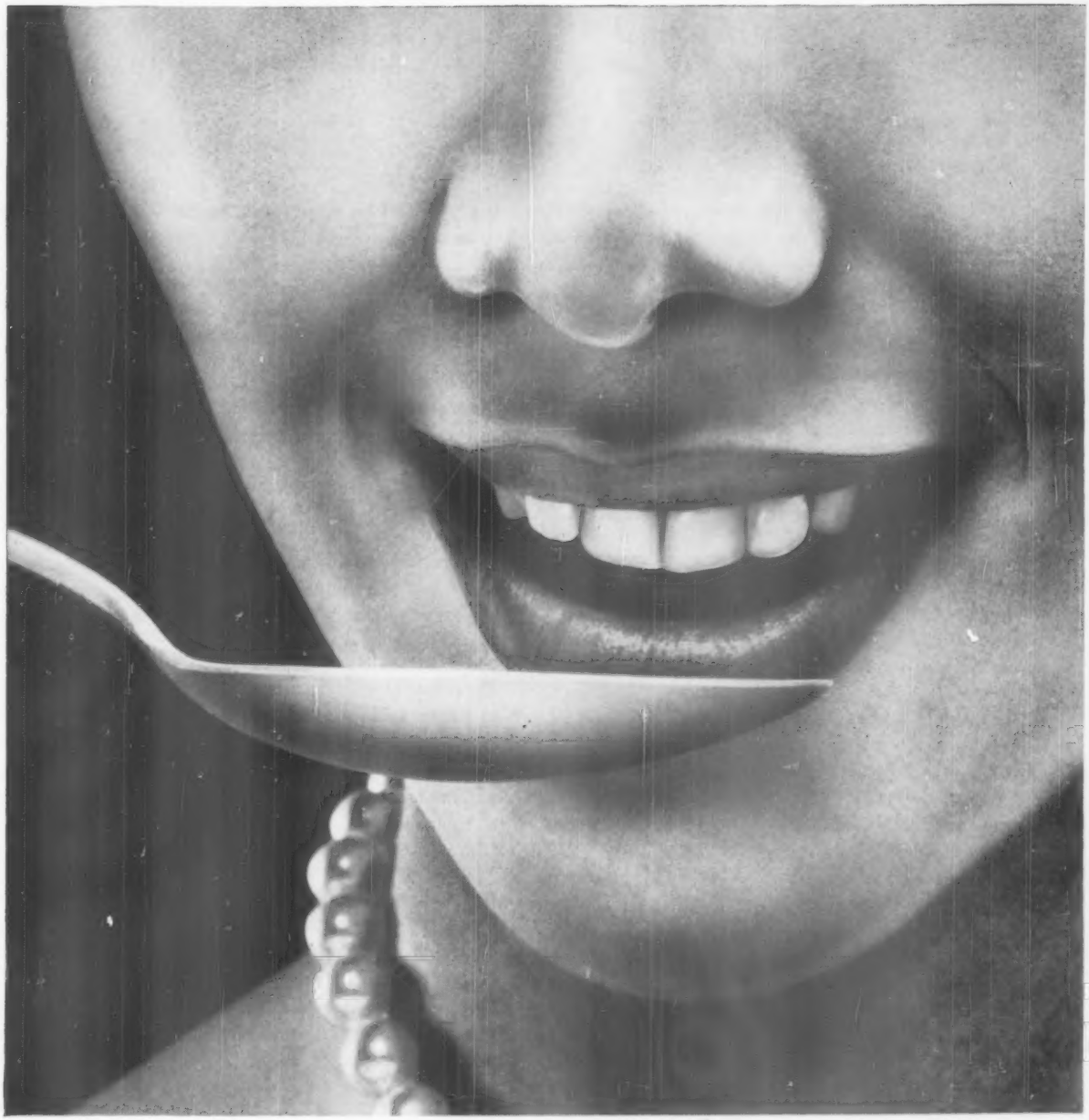

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Table 2. Hunter color readings of red tart cherries canned from samples of fresh fruit classified according to ΔOD 590–620 values.

Samples[a]	L[b]	a_L	b_L	a_L/b_L
Class 1	35.1	15.4	18.5	0.83
Class 2	33.8	16.5	16.7	0.99
Class 3	25.3	17.8	9.3	1.91
Class 4	21.5	17.0	5.8	2.93
Class 5	18.2	15.5	4.6	3.37
Commercial A	18.8	19.8	7.4	2.68
Commerical B	20.9	17.8	7.6	2.34

[a] Arranged, Class 1, having ΔOD 590–620 value associated with least-red color, to Class 5, with most-red color.
[b] L = relative lightness, from 0, black, to 100, white.
a_L = generally redness (+) to greenness (−)
b_L = generally yellowness (+) to blueness (−)

and Whittenberger, 1956; LaBelle *et al.*, 1958); hence, studies were made of the effect of this type of mishandling on light-transmittance characteristics. In exploratory tests, mature cherries were severely bruised by rubbing them between the fingers, and then placed for several hours in sunlight or other high-temperature environment. Curves of OD from *ca.* 540–800 mμ were run on these individual cherries, before and after treatment. A marked increase in OD occurred through most of this range. The curves in Fig. 3 show this change. They are actual tracings from an individual cherry (No. 4 in Table 3) that received the above treatment.

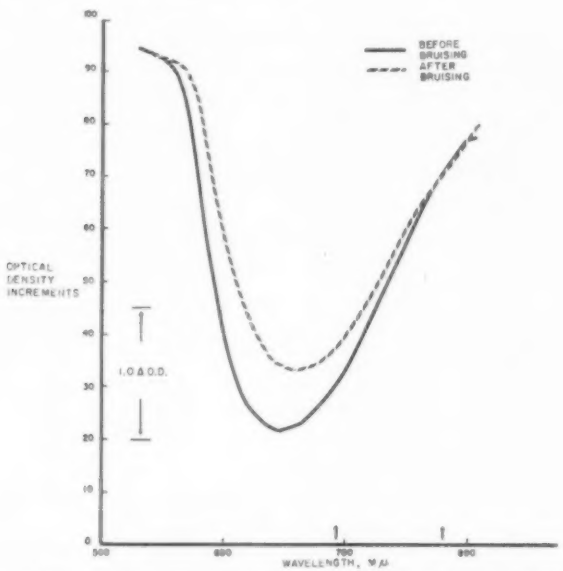

Fig. 3. Rephobiospect curves of an individual cherry before and after induced scald damage.

Table. 3. Effect of bruising red tart cherries and holding several hours, on their light-transmittance characteristics at ΔOD 780–695.

Cherry number	Before treatment	After treatment
1	10	21
2	11	17
3	10	17
4	9	18
5	12	21
6	13	22
7	15	26
8	13	25
9	15	24
10	14	23

The changes in the OD curves below *ca.* 620 mμ are apparently due to dispersal of anthocyanin pigments from the skin into the flesh, and to a general increase, over a wide spectral range, in light-scattering characteristics of the tissue and of brown substances due to oxidation in the tissue. These factors tend to increase OD at the shorter wavelengths relativ. to the longer wavelengths. A ΔOD measurement of bruised fruit in the region *ca.* 550–620 mμ for indicating anthocyanin content will be influenced by induced damage. Such a measurement would indicate that a moderately scalded cherry has more anthocyanin than a similar unscalded cherry, even though extraction procedures indicate no apparent alteration in anthocyanin content.

A measurement of fruit damage independent of anthocyanin content and maturity would therefore be particularly advantageous. The wavelength region 670–800 mμ was selected for further study because previous work had indicated that measurements in this area might be insensitive to anthocyanin content of sound intact cherries (Table 1, Col. 7). OD curves were recorded from a series of cherries before and after bruising and holding for several hours. The readings at 780 and 695 mμ were taken off, and the OD differences calculated. These data showed that bruising caused an increase in ΔOD 780–695 in every specimen (Table 3). Individual fruit that, on instrument evaluation, obtained a ΔOD 780–695 value below 15, would be undamaged by scald, and any above 17 would be damaged. These results indicated considerable promise in the use of the longer wavelength measurements for scald damage.

Estimation of anthocyanin content and stage of maturation of sound cherries (1960 harvest). A spectrum of fruit maturities was attained as described under Materials and Methods. The fruits were carefully removed from the trees and brought to the laboratory, where light-transmittance measurements were made on the Hortispect, followed by weighing, pitting, soluble-solids estimation, and extraction of anthocyanins. After review of the light-transmittance curves, it was decided to read OD at 540 and 612 mμ.

Changes in samples harvested during the period June 25 to July 22 are shown in Table 4. The average OD of anthocyanin extracts (corrected for fruit weight) gradually declined through the harvest period. The ΔOD 540–612 and the wavelength of peak transmittance increased. Average percent soluble solids showed some seasonal trend but was erratic.

The highly significant coefficient of correlation between anthocyanin contents of individual sound fruit and ΔOD 540–612 averaged 0.83 for 274 observations. Anthocyanin contents were expressed as OD of extract divided by pitted weight. It is suggested that a measurement of sound intact fruit at ΔOD 540–612 will afford a reliable index of stage of maturity as it relates to anthocyanin development.

Evaluation of bruised and scalded cherries (1960 season). Samples of cherries were bruised and then held in contact with each other for 20 hr—in cold water, or dry at room temperature or in sunlight. These, together with the unbruised fruit held at room

Table 4. Summary of anthocyanin and maturity evaluation studies, 1960 harvest season (each value is average of 10 cherries).

Harvest date	Bloom condition at tagging date[a]	Readings by intact-fruit spectrophotometry: Fruit extract (optical density ÷ pitted weight)	ΔOD 540–612	Wavelength of peak transmittance	Fruit weight (g)	Percent soluble solids
June 25	P	.....	.....	.....	.....	.....
	F	.0632	47.3	598	3.92	13.21
	A	.0238	44.0	596	3.67	16.08
	Av.	.0622	46.4	597	3.80	14.65
June 29	P	.0606	48.8	597	3.67	13.21
	F	.0943	57.7	606	4.60	14.60
	A	.0814	58.1	602	3.93	13.90
	Av.	.0786	54.6	602	4.07	13.90
July 1	P	.0857	52.6	599	4.49	13.35
	F	.1053	62.7	606	4.43	14.54
	A	.0996	63.1	603	4.46	14.46
	Av.	.0972	59.7	603	4.46	14.12
July 5	P	.1079	59.2	601	4.41	13.71
	F	.1322	65.0	606	4.69	14.44
	A	.1378	63.3	606	4.40	14.65
	Av.	.1260	62.5	604	4.50	14.28
July 8	P	.1320	63.3	604	4.08	14.91
	F	.1919	71.0	615	4.21	16.32
	A	.1386	67.1	611	4.08	15.30
	Av.	.1534	67.0	610	4.12	15.51
July 12	P	.1377	65.4	608	4.41	14.54
	F	.1263	61.6	606	4.40	14.59
	A	.1043	66.7	610	4.61	15.10
	Av.	.1227	64.6	608	4.47	14.74
July 15	P	.2062	73.6	612	3.77	16.29
	F	.1408	68.1	605	4.62	15.06
	A	.1946	73.5	614	4.00	16.25
	Av.	.1737	69.3	610	4.13	15.87
July 19	P	.1818	68.3	614	4.26	15.27
	F	.1607	69.9	616	4.91	15.75
	A	.1691	69.3	615	4.77	16.01
	Av.	.1706	69.2	615	4.65	15.68
July 22	P	.....	.....	.....	.....	.....
	F	.1712	72.3	614	4.68	16.19
	A	.1793	73.2	612	4.68	16.47
	Av.	.1750	72.7	613	4.68	16.33

[a] P = pre-full bloom; F = full bloom; A = after full bloom.

temperature for the same period, were the experimental treatments, which were repeated four times from July 12 to 21.

Light-transmittance measurements were made on all the cherries prior to the beginning of each experiment, using the Hortispect and the ODDM adjusted to read in the long wavelengths, specifically ΔOD 780–695. The ΔOD 540–612 value was calculated from the Hortispect curves. After the experimental treatments, the measurements were made again, together with the visual evaluation of external and internal scald. Per cent soluble-solids readings were followed by anthocyanin extraction. The data covering 4 treatments, 4 dates, and 4 replications (individual cherries) were analyzed for variance, and the results are shown in Table 5.

External scald and internal damage symptoms were apparent in the bruised cherries, and internal cloudiness was particularly prominent in those held at room temperature and in sunlight. The change in ΔOD 780–695 measurement of these cherries was highly significant, and increased with the elevated temperatures.

Fig. 4 shows the frequency distributions of all observations, ΔOD 780–695, made on the ODDM of unbruised and bruised cherries held in air for 20 hr at elevated temperatures. These curves substantiate the preliminary work of 1959. It is significant that unbruised cherries held 20 hr in air at 80°F show no scald damage. The effect of bruising, however, is quite evident after holding 20 hr in air at 80–90°F. Such information may be applied to a system of acceptance or rejection of fruit for manufacture. Fruits not exceeding a value of 33 (Fig. 4) would be acceptable, whereas fruits exceeding 35 would be rejected for scald damage. Sound fruits may then be evaluated with an index of anthocyanin content, to classify for uniformity of color and stage of maturity.

Observations of bruised cherries at ΔOD 540–612 were affected by induced scald, and values increased significantly in those lots held at high temperatures (Table 5). However, the extracted anthocyanin content was not significantly changed, indicating that the increase in ΔOD 540–612 values was due not to in-

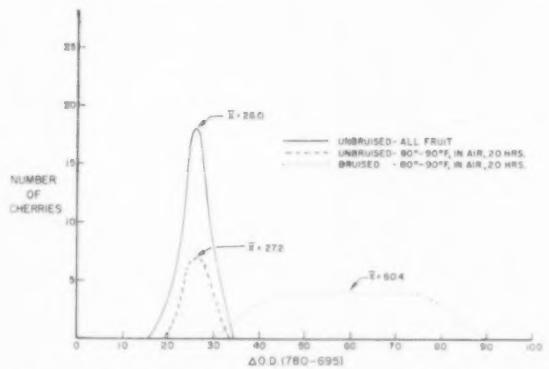
NUMBER OF CHERRIES
X̄ = 28.0
X̄ = 27.2
X̄ = 60.4
UNBRUISED - ALL FRUIT
UNBRUISED - 80°-90°F. IN AIR, 20 HRS.
BRUISED - 80°-90°F. IN AIR, 20 HRS.
ΔO.D. (780-695)

Fig. 4. Distributions of numbers of cherries obtaining ΔOD 780–695 values, under experimental treatment, where under 33 were undamaged, above 35 damaged by scald.

Table 5. Effect of bruising and holding 20 hours, on the light-transmittance characteristics and other quality measurements in red tart cherries (all data are means of 16 treatments).

Bruising treatment	Holding treatment	ΔOD 540–612 after treatment	Gain of ΔOD 540–612 during treatment	Fruit extract (optical density ÷ pitted weight)	Pitted wt. (g)	ΔOD 780–695 after treatment	Gain in ΔOD 780–695 during treatment	Percent soluble solids after treatment	Internal damage index	External "scald" index
None	80°F in air	71.5	0.9	.172	3.82	27.6	0.9	16.3	0.8	0.0
Bruised	40°F in water	73.9	2.4	.162	4.08	34.3	6.8	15.0	5.5	0.3
Bruised	80°F in air	76.8	5.4	.179	3.58	56.7	30.9	16.4	7.1	2.1
Bruised	Sunlight[a]	78.3	6.3	.167	3.46	71.5	45.8	16.4	7.9	4.2
LSD	.05 (between means)	3.50	2.8	nsd[b]	0.28	8.4	8.3	nsd	0.9	0.8

[a] Air temperature exceeded 90°F during hottest part of day.
[b] Not significantly different at .05 level.

creased anthocyanin but to dispersion, light scattering, and brown substances, as discussed earlier.

The 540-mμ wavelength was chosen from recorded curves because it was close to the maximum absorption of anthocyanin; however, the absorption of energy at this wavelength, in the case of whole intact mature cherries, is so great that it is not practical to measure the energy at that wavelength with abridged type instruments. A portable ΔOD instrument to measure ΔOD 590–620 is more practical for sorting sound fruit for color than is ΔOD 540–612.

CONCLUSIONS

These results indicated that there is a possibility for a more complete evaluation of the quality of red tart cherries by the technique of light-transmittance measurement of the intact fruit. It is suggested that scald damage in cherries can be evaluated by ΔOD 780–695 in a manner that is independent of color, and unscalded fruit can then be evaluated for color.

Further data on the performance of newly constructed instruments to measure scald damage by ΔOD 780–695 will come from the results of trials in the field. Separations for color of sound intact fruit by determinations of anthocyanin pigment development will be studied as an important quality factor in both canned and frozen cherries.

ACKNOWLEDGMENTS

The authors thank the C. H. Musselman Company, Biglerville, Pa., for furnishing the cherries and plant facilities used in this research, and Dr. C. H. Hills, Eastern Utilization Research Division, U. S. Department of Agriculture, who made helpful suggestions for the scald experiments.

REFERENCES

Anon. 1946. U. S. Standards for red sour cherries for manufacture. U. S. Dept. Agr. Production and Marketing Admin. Mimeo. release.

Anon. 1949a. U. S. Standards for grades of canned red sour (tart) pitted cherries. U. S. Dept. Agr. Production and Marketing Admin. Mimeo. release.

Anon. 1949b. U. S. Standards for grades of frozen red sour (tart) pitted cherries. U. S. Dept. Agr. Production and Marketing Admin. Mimeo. release.

Birth, G. S. 1960. Measuring the smut content of wheat. *Trans. Am. Soc. Agr. Eng.* **3**, 19.

Birth, G. S., and K. H. Norris. 1958. An instrument using light transmittance for non-destructive measurement of fruit maturity. *Food Technol.* **12**, 592.

Birth, G. S., K. H. Norris, and J. N. Yeatman. 1957. Non-destructive measurement of internal color of tomatoes by spectral transmission. *Food Technol.* **11**, 552.

Ernest, Jane V., G. S. Birth, A. P. Sidwell, and C. Golumbic. 1958. Evaluation of light transmittance techniques for maturity measurements of two varieties of prune-type plums. *Food Technol.* **12**, 592.

Floate, R. 1960. Quality cherries are necessary for a prosperous cherry industry. Ann. Rept. Secy. Mich. State Hort. Soc. **89**, 32.

Hills, C. H., and R. T. Whittenberger. 1956. Bruising causes cherry discoloration. *Canner & Freezer* **123**(4), 14.

Hills, C. H., R. T. Whittenberger, W. F. Robertson, and W. H. Case. 1953. Studies on the processing of red cherries. II. Some of the effects of bruising on the yield and quality of canned Montmorency cherries. *Food Technol.* **7**, 32.

LaBelle, R. L., J. C. Moyer, W. B. Robinson, and D. B. Hand. 1958. Causes of scald in Red Tart Cherries. *Food Technol.* **12**, 94.

Sidwell, A. P., G. S. Birth, J. V. Ernest, and C. Golumbic. 1961. The use of light transmittance techniques to estimate the chlorophyll content and stage of maturation of Elberta peaches. *Food Technol.* **15**, 75.

Snedecor, G. W. 1940. Statistical Methods. Collegiate Press, Inc. 3rd ed. Ames, Iowa.

Wagenknecht, A. C., D. M. Scheiner, and J. P. Van Buren. 1960. Anthocyanase activity and its possible relation to scald in sour cherries. *Food Technol.* **14**, 47.

The Effect of Bruising and Aging on the Texture and Pectic Constituents of Canned Red Tart Cherries[a]

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(Manuscript received July 28, 1961)

SUMMARY

Red, tart cherries allowed to stand before being canned, either with or without having been previously bruised, were much firmer after canning than were similar cherries canned immediately after harvest. During the aging period a portion of the pectin was completely demethylated to form pectic acid. Most of the pectin, however, was apparently unchanged in chain length or degree of esterification. Histological examination of the tissue showed that the cell walls of the aged cherries were more rigid and less easily separated from each other than were the cell walls of cherries canned immediately after harvest.

INTRODUCTION

Red, tart cherries are harvested during midsummer when the temperature is often 80–90°F. The cherries are severely bruised in commercial harvesting (Whittenberger, 1952). The period between harvest and unloading at the plant may be 4, 8, or even 20 hr. This constitutes an aging period, unintentional but nonetheless important. In addition, at the processing plant, the cherries are commonly soaked in cold water for 6–20 hr to chill, clean, and firm them before pitting. Thus there are two aging periods, one in air and one in water.

Whittenberger and Hills (1953) reported that aging in air or in water at various temperatures increased yield (weight of cooked, drained cherries/weight of fresh, whole cherries) and gave a firmer texture. If the cherries are bruised before the aging period, the increase in yield may be even more pronounced. The aged or bruised and aged cherries are firmer, have a greater bulk volume, and retain their rounded shape better than do unaged cherries. This is shown in Fig. 1. Fig. 2 shows the shapes of a few individual cherries from each container.

The water-insoluble constituents of tart cherries are being investigated with a view to determining whether they are changed by bruising and aging before canning. This paper reports the effect of these treatments on the pectic compounds and on the appearance of the cell walls.

METHODS

Chemical investigations. *Preparation of samples.* Montmorency cherries from orchards in Michigan, Pennsylvania, and New York State were used. The cherries were picked carefully by hand, put immediately into ice water, and taken to the processing plant. The control cherries were drained, weighed, and canned immediately. Cherries for the aging treatment were drained, weighed, and allowed to stand at room temperature for 24–48 hr before being pitted. Bruising was done by dropping the cherries several times, a few at a time, onto an inclined tray from a height of 1–3 ft. The bruised cherries were then either canned at once or aged first.

Cherries in all treatments were pitted, exhausted to a center can temperature of 170°F, sealed, and cooked 12 min in a boiling water bath. Analyses were made several months after canning and were calculated on the basis of fresh whole fruit.

The canned cherries were ground in a Waring blender, mixed with 3½ volumes of ethyl alcohol, allowed to stand overnight, and then filtered through a nylon cloth. The alcohol-insoluble solids were dried and used for pectin and pectic acid extractions.

Pectin. Water was added to the dry alcohol-insoluble solids in a tared beaker to form a slurry, which was then adjusted to pH 1.8 with hydrochloric acid and heated 1 hr on a steam bath. After heating, the weighed slurry was filtered through a nylon cloth and the filtrate weighed. Pectin was precipitated from the filtrate with acidic ethyl alcohol, washed, dried, and weighed, correcting for the amount held in the unfiltered solids during the filtration (Owens *et al.*, 1952). The insoluble solids on the filter cloth were rinsed with hot water, returned to the beaker, and twice re-extracted at pH 1.8 on the steam bath, for ½ hr each time. After the last extraction, the non-pectin insoluble solids were thoroughly rinsed with hot water, alcohol, and acetone, dried, and saved for pectic acid extraction.

Pectic acid or polygalacturonic acid. Water was added to the insoluble solids from which pectin had been extracted, and small amounts of dilute sodium hydroxide were added over a period of several hours with intermittent stirring, care being taken that pH never rose above 7.5. When the pH had remained at 7.5 for 2 hr without dropping, the solution was filtered and the solids re-extracted twice more in the same way. The filtrate was acidified with hydrochloric acid, three volumes of alcohol were added, and the precipitated pectic acid was filtered off, washed, dried and weighed.

Esterification. Percent esterification was determined by the method described by Owens *et al.* (1952). For the pectic acid precipitate, the method of Feldstein and Klendshoj (1954) for methanol was also used.

Anhydrouronic acid. Anhydrouronic acid was determined by the method of Ikawa and Niemann (1949).

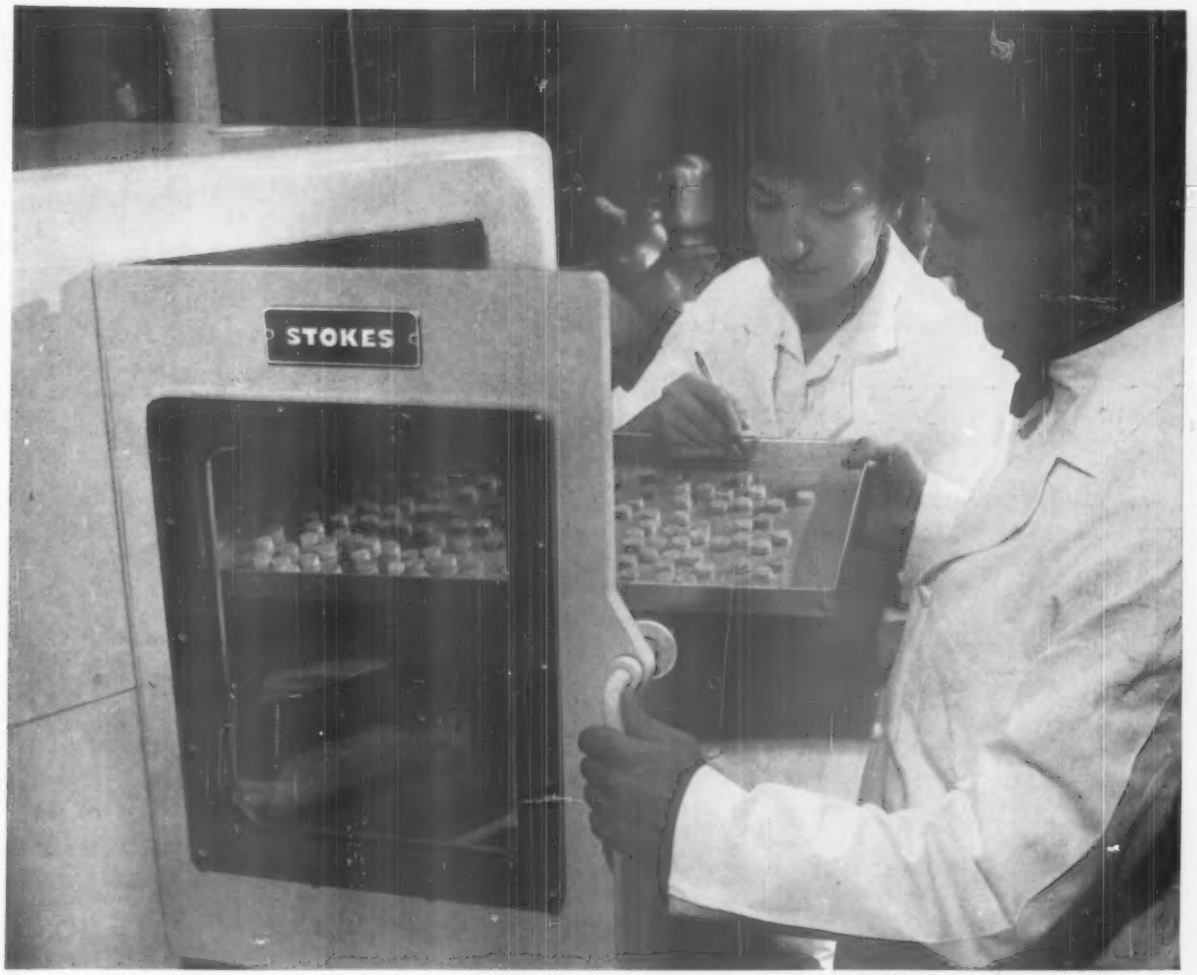
Calcium. The procedure of Appleton *et al.* (1959) was followed, with calcein used as the indicator. However, when pectic acid or other insoluble samples were analyzed, the method was modified by extracting with ethylenediaminetetraacetic acid (EDTA) and back-titrating with standard calcium solution.

Histological investigations. The cherries used were obtained from an orchard at Biglerville, Pennsylvania. They were picked and hauled in cold water to the processing plant, as were the samples for chemical analysis. The control cherries were canned immediately by the usual procedure, but without being pitted. Those given the aging treatment were allowed to stand 48 hr at room temperature, and then canned, also without being pitted.

The canned cherries were fixed in formalin–acetic acid–alcohol solution, and then washed in water until free of alcohol.

[a] Presented at the Twenty-First Annual Meeting of the Institute of Food Technologists, New York, May 8, 1961.

[b] Eastern Utilization Research and Development Division, Agricultural Research Service, Department of Agriculture.



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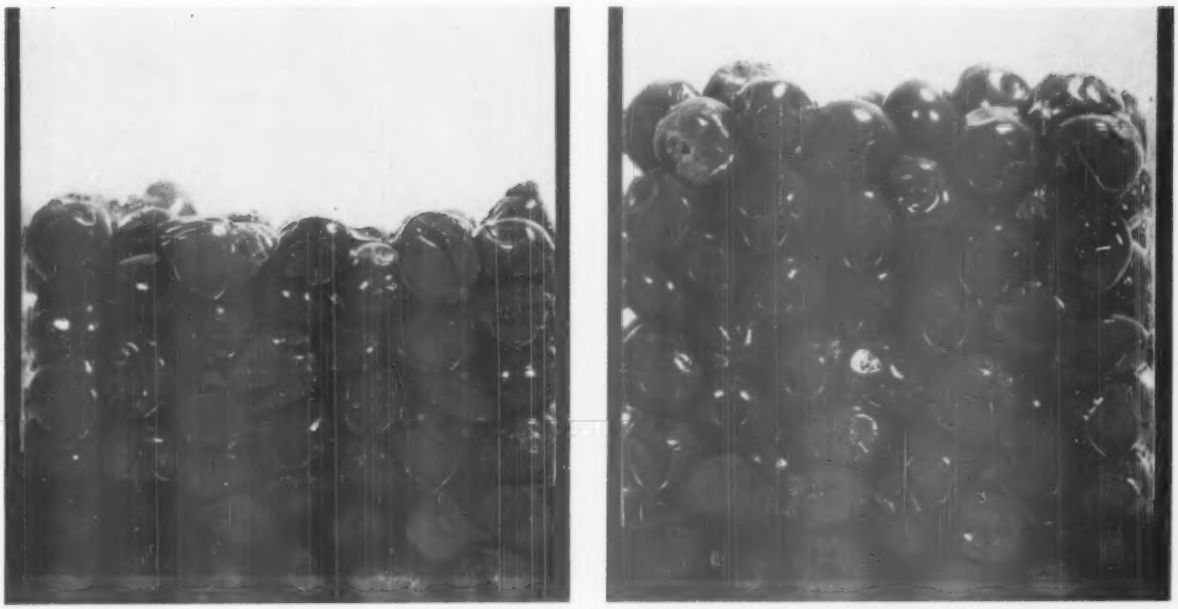


Fig. 1. Effect of bruising and aging on firmness of red, tart, pitted cherries. Each jar contains pitted, canned cherries equivalent to 450 g of fresh, whole cherries. Left, control, processed immediately after harvesting. Drained weight = 68%. Right, cherries bruised twice by dropping from a 2-ft height, allowed to stand 8 hr in air at room temperature, and then 16 hr in ice water before being processed. Drained weight = 74%.

After they had been quartered and the pits removed, radial sections of 240 or 300 μ were cut on a freezing microtome. Those sections which were not to be extracted were stained with ruthenium red or methyl green and mounted in glycerine jelly. The rest of the sections were transferred to 0.5*N* hydrochloric acid and heated 2 hr on a steam bath to extract the pectin. After being washed, some of the sections were stained and mounted in the same way as the untreated sections. The remaining sections were placed overnight in buffer at pH 7.5 to remove the pectic acid. After being washed, the sections were stained and mounted in the usual way.

RESULTS

Chemical investigations. Table 1 shows mean values from analyses of samples from Michigan for one season. Results were similar for other seasons and other areas, but the exact values varied from location to location and season to season. In addition, severity of bruising and time and temperature of aging varied for the individual locations and seasons, since it was desired to get the maximum firming effect without mangling the fruit or allowing it to spoil. Samples in Table 1 are arranged in order of increasing severity of treatment. Sample B, although supposedly given no aging period, was actually aged for 20–30 min after bruising, since it took about that long for the cherries to be pitted and heated to boiling. This was not long enough to firm the cherries visibly, and the bruising may even have softened them somewhat by mechanically rupturing the cells, but apparently it was long enough for some enzymatic change to take place. Sample C was much firmer than A and B, and sample D was slightly firmer than C. In the case of D, the time elapsed after bruising was enough that the cherries recovered from the mechanical effects of the bruising and became even firmer than C, which was aged for the same period but not bruised before being aged.

Fig. 2. Effect of bruising and aging on appearance of individual cherries. Cherries on left and right received the same treatments as those in Fig. 1.

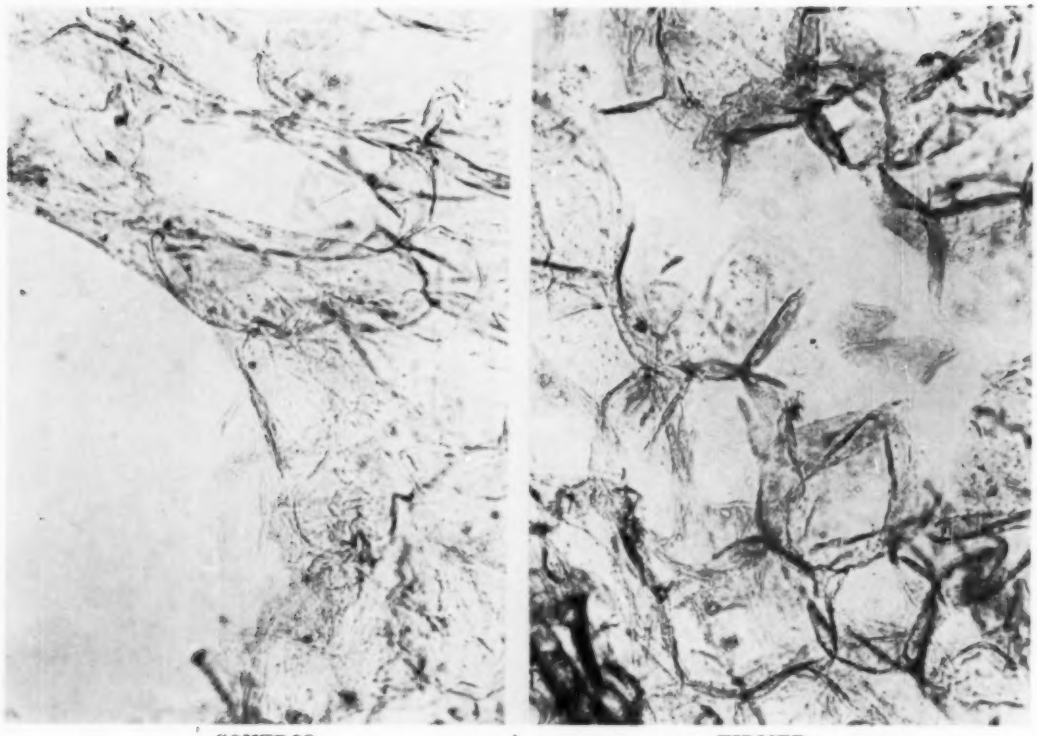
The amount of the pectin precipitate decreased with increasing severity of treatment. Since the pectin precipitate was fairly impure, containing only about 60% anhydrouronic acid (AUA), a better measure of the acid-soluble pectin content is given by calculating it on the basis of the percent AUA found in the pectin precipitate. The control was found to contain 0.16% pectin as AUA, and the most severe treatment, bruised and aged, 0.10%, almost a 40% reduction. The chain length of the pectin, as measured by viscosity of the pectin solution, did not appear to differ among the treatments. The degree of esterification, usually 45–55%, tended to be somewhat variable, but did not decrease much, if at all, with treatment.

Pectic acid, as shown in Table 1, increased in the treated samples. In the case of the most severe treatment, bruised and aged, the increase was about threefold. The amount of alkali necessary to neutralize and extract the pectic acid from the acid-insoluble solids increased from sample A to D. This was proportional to the amount of pectic acid present. The isolated pectic acid had an AUA content of about 80% and an equivalent weight by titration of 195, compared to the theoretical value of 176 for anhydrogalacturonic acid.

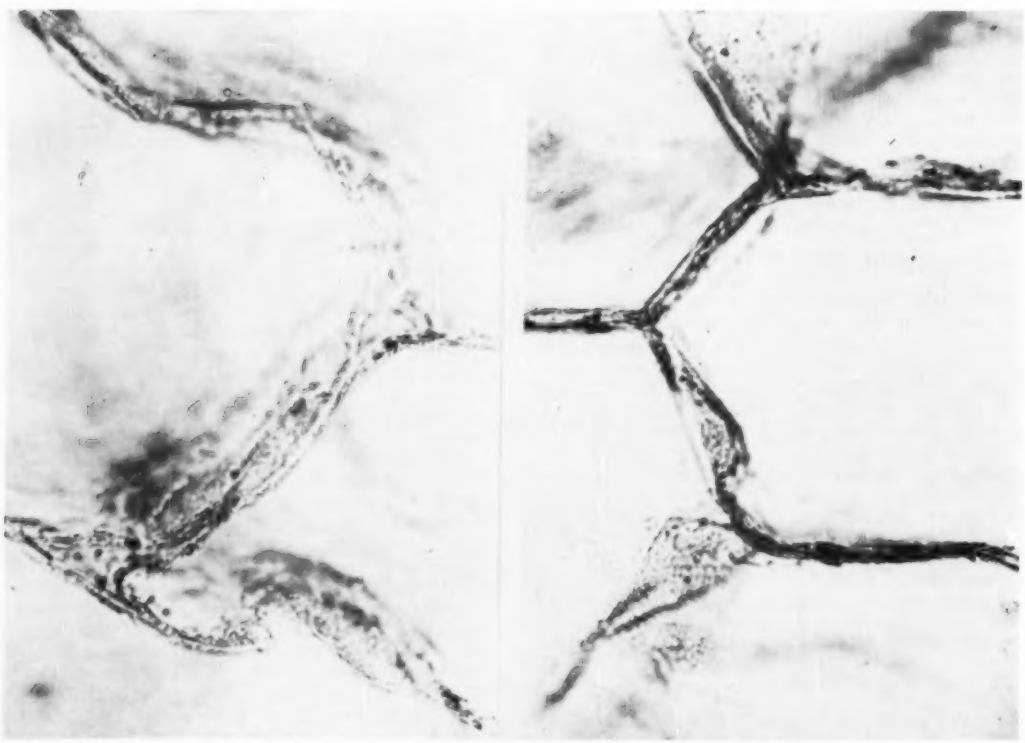
The carboxyl groups of pectic acid were esterified only about 2% as determined both by the titration method (Owens *et al.* 1952) and by the more specific methyl determination of Feldstein and Klendshoj (1954). No relation was found between firmness and the calcium content of the pectic acid, or with the calcium content of the pectin or remaining insolubles.

Although no derivatives were made, the pectic acid hydrolysate resembled galacturonic acid in its paper chromatographic characteristics and in its ultraviolet absorption spectrum after reaction with 79% sulfuric acid (Ikawa and Niemann, 1949). Furthermore, when borate was added in the latter reaction, there was no shift in the wavelength of maximum absorption, as would have been the case if glucuronic rather than galacturonic acid had been present (Gregory, 1960).

The weight of insoluble solids remaining after removal of pectin and pectic acid was higher in the firm than in the soft cherries. The component responsible for this difference is still being investigated. *(Plates follow; text continued p. 530)*



CONTROL A FIRMED



CONTROL B FIRMED

Fig. 3. Photomicrographs of radial sections of red tart cherries, stained with methyl green. Control was canned immediately after harvesting. Firmed was allowed to stand 24 hr at room temperature before being canned. A) ×125; B) ×500.

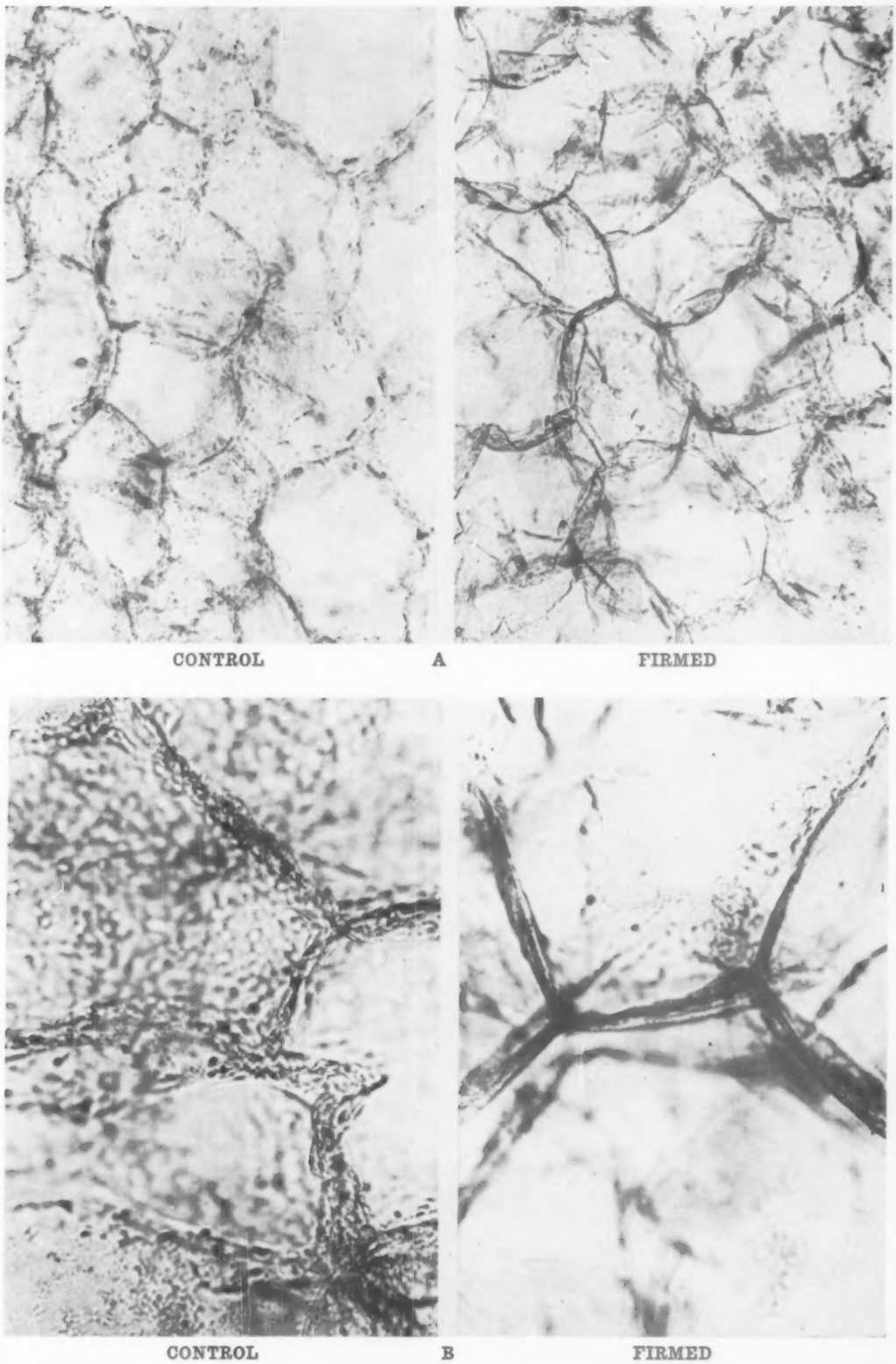


Fig. 4. Photomicrographs of radial sections of red, tart cherries after extraction of pectin with acid, stained with methyl green. Control was canned immediately after harvesting. Firmed was allowed to stand 24 hr at room temperature before being canned. A) ×125; B) ×500.

Table 1. Results of analyses of red, tart, pitted cherries firmed by bruising and aging before canning.

Sample no.	Treatment	Percentage of raw, unpitted fruit					
		Pectin (gravimetric)	Pectin (calculated on basis of AUA content)	Pectic acid (gravimetric)	Pectic acid (calculated on basis of AUA content)	Total AUA	Insoluble solids remaining
A	Control, not aged or bruised	0.27	0.16	0.04	0.03	0.19	0.34
B	Bruised 3 times from 3 ft, not aged	0.23	0.14	0.06	0.05	0.19	0.35
C	Aged 24 hr, not bruised	0.18	0.11	0.10	0.08	0.19	0.37
D	Bruised 3 times from 3 ft, aged 24 hr	0.17	0.10	0.12	0.10	0.20	0.39

Histological investigations. Fig. 3-A shows cell walls of untreated and of firmed, canned cherries. When the section was gently pulled apart with a pair of needles, adjacent cell walls in the soft or untreated cherries separated easily, the cells remaining whole. When, however, the tissues of aged, firm cherries were pulled apart, the cell walls tended to fracture rather than separate at the middle lamella, leaving sharp edges of broken cell walls. Furthermore the control sections were easily pulled out of shape whereas sections from the firmed cherries were very rigid and resisted distortion.

Fig. 3-B shows the same sections at a higher magnification. As can be seen, there was not much difference in the cell walls themselves. Both methyl green and ruthenium red appeared to stain the whole cell wall indiscriminately, indicating either that the stains were not specific for cellulose and pectic substances, respectively, or that the cell walls were composed of a complex of associated polysaccharides that could not be resolved at this magnification. No difference in degree of esterification was found among treatments with the hydroxylamine test of Gee *et al.* (1959), with visual comparison.

Fig. 4 shows the appearance of the sections after the pectin had been extracted with hot hydrochloric acid. The firmed cherries still had definite cell walls, whereas in the soft cherries the cell walls had almost lost their identity. When the pectic acid remaining in the sections was extracted with dilute sodium hydroxide, the cell walls of the soft cherries lost what little cell wall structure they had left, whereas the firmed cherry sections were apparently unchanged.

When sections were treated with pectin methylesterase and polygalacturonase instead of the chemical treatments to remove pectin and pectic acid, the cell walls of the control cherries disintegrated but the cell walls of the firmed cherries remained unchanged.

Cell walls of control and firmed cherries differed less when sections were made from raw cherries than when canned cherries were used. However, when pectin was extracted from the sections, cell walls of the raw cherries looked like those of extracted canned cherries, as in Fig. 4.

DISCUSSION

When cherries are allowed to stand before being pitted, they are, of course, still alive and respiring. Bruising increases the respiration rate of cherries (Pollack *et al.*, 1958), just as it does with other plant tissues. Something apparently occurs between harvesting and canning that increases the rigidity of the cell walls, so that the cherries maintain their rounded shape, have a greater bulk volume, and appear to hold more water and hence weigh more than do cherries canned immediately after harvest.

In studies of the tissue softening of fruits during ripening, textural changes have been found to be related to changes in the percent esterification of the pectin in the cell walls or the middle lamella. Van Buren *et al.* (1960) reported that snap beans become firmer during the blanching period because of demethylation of the pectin by pectin methylesterase to the less soluble pectic acid. Toughening of stored frozen cherries was also found to be related to a lower degree of esterification of the pectin (Gee and McCready, 1957). In the firming of aged and bruised-aged cherries, however, the degree of esterification of most of the pectin is changed very little if at all. At the same time, another portion of the pectin, perhaps that located in the middle lamella or in some specific part of the cell wall, is almost completely demethylated. This demethylation occurs while the cherry is still alive and may quite possibly be due to increased pectin methylesterase activity.

The canning process, in which cherries with a pH of about 3.5 are heated, may also be looked upon as a mild pectin extraction. Pectin, therefore, is partially removed during canning. This may account for the fact that histological differences between control and treated cherries were greater in canned than in raw fruit. With some of the pectin removed, the control cherries are flabby and easily distorted, and the non-rigid cell walls readily separate from each other. The extreme, of course, is the complete removal of pectin by heating with acid or treatment with pectin enzymes, which causes near disintegration of the sections. The treated (firm) cherries, in contrast, have a definite, rigid cell wall structure even when the pectin is removed. The presence of pectic acid may contribute to this increased cell wall rigidity, but since the rigidity is maintained even when all pectic acid is removed with sodium hydroxide, it seems likely that still another factor is involved. At any rate, during the aging period some compound is formed that imparts sufficient rigidity to the cell walls that the cooked cherry is still firm and resists distortion.

ACKNOWLEDGMENTS

The authors are grateful to Dr. Theone C. Cordon and Mr. Alfred L. Everett for the use of facilities for the histological studies, and to Mr. W. O. Harrington for assistance in processing the samples.

REFERENCES

Appleton, H. D., M. West, M. Mandel, and A. M. Sala. 1959. The rapid determination of calcium in biologic material. *Clin. Chem.* **5**, 36.

Feldstein, M., and N. C. Klendshoj. 1954. Determination of methanol in biological fluids by microdiffusion analysis. *Anal. Chem.* **26**, 932.

Gee, M., and R. M. McCready. 1957. Texture changes in frozen Montmorency cherries. *Food Research* **22**, 300.

Gee, M., R. M. Reeve, and R. M. McCready. 1959. Reaction of hydroxylamine with pectinic acids. Chemical studies and histochemical estimation of the degree of esterification of pectic substances in fruit. *J. Agr. Food Chem.* **7**, 34.

Gregory, J. D. 1960. The effect of borate on the carbazole reaction. *Arch. Biochem. Biophys.* **89**, 157.

Ikawa, M., and C. Niemann. 1949. A spectrophotometric study

(Text concluded on page 531)

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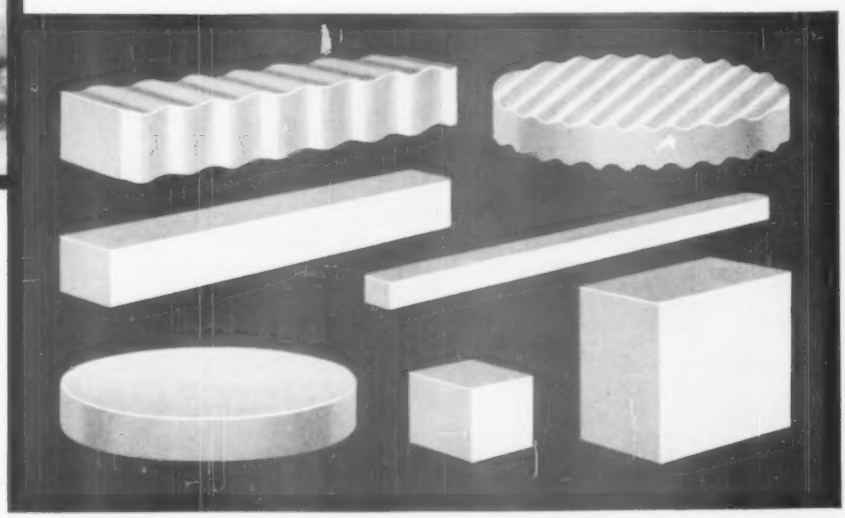

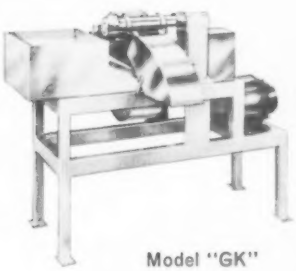

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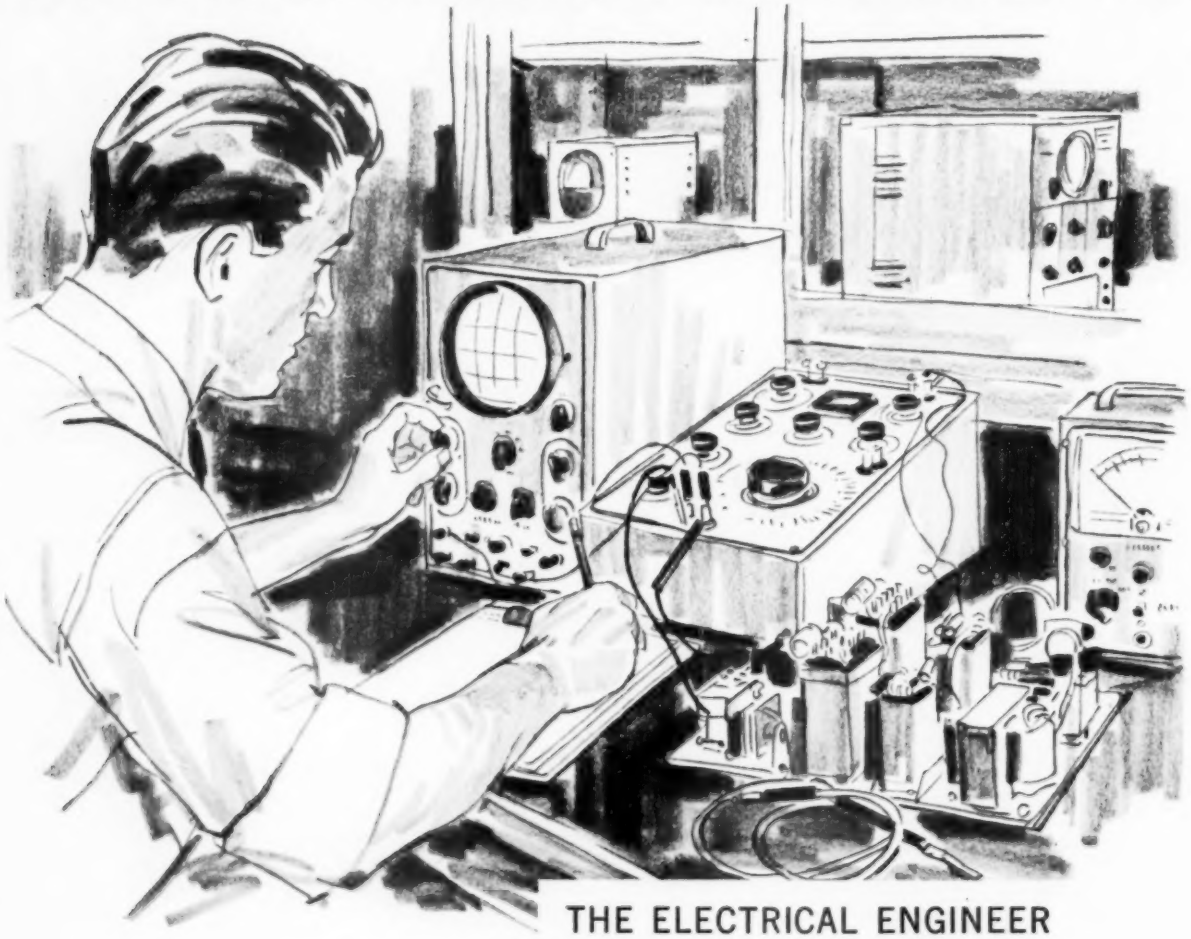

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of the behavior of carbohydrates in 79% sulfuric acid. *J. Biol. Chem.* **180**, 923.

Owens, H. S., R. M. McCready, A. D. Shepherd, T. H. Schultz, E. L. Pipper, H. A. Swenson, J. C. Miers, R. F. Erlandsen, and W. D. Maclay. 1952. Methods used at Western Regional Research Laboratory for extraction and analysis of pectic materials. *U. S. Dept. Agr. Bur. Agr. Ind. Chem.*, AIC, 340.

Pollack, R. L., R. T. Whittenberger, and C. H. Hills. 1958. Studies on cherry scald. II. Relationship between bruising and respiration in air. *Food Technol.* **12**, 106.

Van Buren, J. P., J. C. Moyer, W. B. Robinson, and D. B. Hand. 1960. Control of firmness in canned snap beans. *Farm Research* **26**, No. 2, 9.

Whittenberger, R. T. 1952. Factors which affect the drained weight and other characteristics of heat processed red cherries. *Food Research* **17**, 299.

Whittenberger, R. T., and C. H. Hills. 1953. Studies on the processing of red cherries. I. Changes in fresh red cherries caused by bruising, cooling, and soaking. *Food Technol.* **7** 29.

Gas-Liquid Chromatographic Studies on the Enzymatic Formation of Volatile Compounds in Raspberries

(Manuscript received May 15, 1956)

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SUMMARY

Headspace sampling over enzyme-substrate reaction mixtures and subsequent analysis by gas-liquid chromatography were shown to be valuable in quantitative enzyme studies when volatile reaction products are involved. An enzyme mixture and a mixture of nonvolatile substrates containing precursors of volatile compounds were prepared from different parts of ripe and unripe raspberries. Their interaction under controlled conditions was shown by gas-liquid chromatographic analysis to produce a number of volatile compounds. Simultaneously the characteristic odor of raspberry developed. Information on the enzymes and on the precursors of the volatile compounds in the substrate mixture was obtained by studying the formation of volatile compounds when enzymes from different sources were added to the substrates. No odor of raspberries developed in these experiments. It could be shown that very likely more than one enzyme, acting on nonvolatile substrates, is responsible for the formation of the volatile compounds in raspberries.

INTRODUCTION

In higher plants, research on the enzymic formation of volatile compounds has been restricted to study of the formation of a few alcohols, acids, and carbonyls found in the tissue as end products of respiration under anaerobic conditions. Hewitt *et al.* (1956) reported that natural food flavors are enhanced when enzymes prepared from fresh food are added to processed foods. Their evidence suggested the presence in food of heat-stable flavor precursors. A large number of examples can be found in a U. S. patent, obtained by Hewitt *et al.* (1960). Bailey *et al.* (1961) studied natural flavor enchancement on the addition of myrosinase to dehydrated cabbage. Gas-liquid chromatography of headspace vapors was used for the first time in investigations in this field, and, by it, enzymic formation of allyl isothiocyanate from a glycoside in the cabbage was demonstrated. Two other isothiocyanates and two sulfides and disulfides were identified. No attempt was made in these studies to study the enzyme reactions *in vitro*. Reese *et al.* (1958) investigated the properties of myrosinase and sinigrinase in detail. In our study, experiments first establish the usefulness under our test conditions of gas-liquid chromatographic analysis of the headspace vapors over reaction mixtures for quantitative enzyme assay. The extraction and preparation of nonvolatile substrates and of enzymes from raspberries is described, and the *in vitro* enzymic formation of natural volatile compounds from ripening fruit is investigated by gas-liquid chromatography. The simultaneous development of the characteristic raspberry odor is observed, and some properties of the enzyme-substrate mixtures are studied.

MATERIALS AND METHODS

Substrates. *Sinigrin:* commercial (Light & Co., Ltd., England). Raspberry substrate mixture (liquid): 12.5 kg unripe raspberries (var. "Taylor"), just before ripening, were minced in a Waring blender with 42.5 L ethanol. Adding 2.16 L of 2*N* NaOH raised the pH to 6.4 and made a total of 57.2 L of 74% alcoholic slurry. The slurry was boiled under reflux for 10 min, cooled, and filtered through cheesecloth and filter paper. The alcohol and part of the water were taken off under reduced pressure (max temp. 45°C), and the residue was steam-distilled at *ca.* 5 cm Hg to reduce the amount of volatiles as much as possible. The pH of the strongly buffered concentrate (2750 ml) was adjusted to 7 with 374 ml 2*N* NaOH and was further concentrated in a rotary film evaporator under re-

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duced pressure to 250 ml of a thick syrup, which was diluted with an equal volume of 0.2 ionic strength phosphate buffer of pH 7. Merthiolate was added for further preservation (5 mg/100 ml).

Raspberry substrate mixture (powder): Another batch of raspberry precursor (var. "Malling Promes") was prepared in the same way except that no steam distillation was applied. After concentration in the rotary film evaporator, enough Celite was added to give the sample a lumpy, granular consistency. The material was lyophilized and finely powdered.

Enzymes. A number of the enzymes used in our experiments were put at our disposal by Dr. E. T. Reese; others were obtained from commerce. Table 1 lists them.

Yellow mustard seed flour enzyme (myrosinase): prepared by washing the flour 4 times with excess acetone and extracting with distilled water. The extract was dialyzed against tap water, and the nondialyzable residue was lyophilized.

Raspberry enzyme: the white center cores of 15 kg of fresh-frozen fully ripe raspberries (var. "Taylor") were removed from the fruits and minced in a Waring blender with 3½ times their volume of cold acetone. After being centrifuged, the tissue residue was rewashed 4 times with cold acetone, centrifuging between every two washings. The residue was finally dried in air and kept at +4°C until used.

Methods and apparatus. All tests were run in 35-ml 4-cm-high conical flasks of 6-cm bottom diameter. Samples in such flasks exposed a large surface area to a small headspace volume, allowing for a quick establishment of liquid-vapor equilibrium. The flasks were closed with rubber serum caps, and headspace vapor samples for application on the gas chromatographic column were taken through the caps with a glass syringe.

Table 1. Effect of enzymes on raspberry substrate mixture.

Enzyme[a]	Peaks of volatile compounds showing in chromatograms as a result of enzyme activity								
Name and/or origin	2	3	4	5	6	7	8	9	10
Raspberry, QM	+	+	+	+	−	−	+	+	+
β-glycosidase, R&H #1	−	−	+	+	+	+	+!	+	+!
Cellulase, Miles Lab. (conc.)	−	−	+	+	−	−	+!	+	+!
Alcoh. dehydrog., N.B., + coenzyme I, B.R.	+	−	+	−	−	−	−	−	−
Lipase, G.B.I.	−	−	−	+	−	−	−	−	−
β-glycosidase of Aspergillus phoenicis, QM 1005	−	−	−	−	−	−	−	−	−
β-glycosidase of Aspergillus luchuensis, QM 873	−	−	−	−	−	−	−	−	−
Alm. emulsin, Richtmyer, N.I.H.	−	−	−	−	−	−	−	−	−
Sinigrinase of Aspergillus sydowi, QM 31c	−	−	−	−	−	−	−	−	−
Erepsin, N.B.	−	−	−	−	−	−	−	−	−
Bromelin, N.B.	−	−	−	−	−	−	−	−	−
Diastase (malt), G.B.I.	−	−	−	−	−	−	−	−	−
Tyrosinase (mushroom), B.R.	−	−	−	−	−	−	−	−	−
Myrosinase, QM	−	−	−	−	−	−	−	−	−

[a] Enzymes 3, 6, 7, 8, and 9 furnished by Dr. E. T. Reese. For nos. 1 and 14, see text. All other enzymes were commercially obtained. Additional information on some of the enzymes: 2) β-glycosidase R&H #1—sample of an Aspergillus enzyme known to be capable of hydrolyzing naringin, hesperidin, oleuropein, and other similar glycosides. 3) Cellulase 10,000 μ/g, Miles (Takamine)—powder containing lactose as a diluent. From *Aspergillus niger*. The preparation was dissolved in water and precipitated with 2 v acetone. The resulting powder contains all of the cellulase while removing 75% of the total solids. 4) Alcohol dehydrogenase—N.B. (yeast), A-grade. 6) β-glucosidase of *Aspergillus phoenicis* QM 1005—more active on cellobiose than on salicin. Acetone precipitate of a dialyzed culture filtrate. 7) β-glucosidase of *Aspergillus luchuensis* QM 873—dialyzed filtrate. Prepared with alcohol. 8) Almond emulsin R.—emulsin extracted and purified at N.I.H. by N.K. Richtmyer and colleagues. A β-glucosidase free of α-glucosidase. 9) Sinigrinase of *Aspergillus sydowi* QM 31c—dialyzed and lyophilized preparation from culture filtrate. Diluted with celite. 13) Tyrosinase (mushroom) lyophilized, B-grade—activity 1000 μ/mg. Commercially obtained: R&H, Rohm and Haas; N.B., Nutritional Biochemicals Corp.; B.R., Biochemical Research; G.B.I., General Biochemicals, Inc. For nos. 1 and 14, see text.

Enzyme reactions were left to proceed in a thermostat at 39 or 30°C. Before vapor samples were taken, the flasks were left for 4 or 2 hr at room temperature to reach liquid-vapor equilibrium.

All reaction media contained 5 mg merthiolate/100 ml to prevent growth of microorganisms, and were made up in phosphate buffer at pH 7.0 of a final concentration of 0.1 ionic strength.

A Pye gas chromatograph with a 20-m Curie Sr^{90} detector at 1750 V, and a 0-5mV 1-sec potentiometric recorder was used for analysis of the vapors. Glass column: 130 × 0.6 cm; 10% di-*n*-decylphthalate on 80–100-mesh firebrick. Unless otherwise noted: column and detector temp. 50°C; argon flow 93 ml/min; sample size 2 ml vapor; sensitivity ⅓ of maximum.

EXPERIMENTAL AND RESULTS

Two sets of experiments were run to establish whether gas-liquid chromatographic analysis of headspace vapors over aqueous solutions could be used. First, a number of flasks were sampled with different concentrations, ranging from 0.001% to 0.025%, of acetone, propionaldehyde, ethyl acetate, and isopropanol in water. After reaching equilibrium at room temperature, headspace vapor samples were analyzed (Fig. 1). In the second series of experiments the well-known enzymic formation of a volatile compound, allylisothiocyanate, from the nonvolatile glycoside, sinigrin, was studied quantitatively by gas-liquid chromatography. The reaction mixture in the flasks consisted of 10 ml buffer, 50 mg sinigrin, and increasing amounts of myrosinase. The flasks were kept 24 hr at 39°C before 2 ml headspace vapor samples were analyzed. The results are shown in Fig. 2. Blanks and separate experiments had shown that no peaks appeared on chromatograms when the substrate and enzymes were run separately under the same conditions, and that the substrate sinigrin was present in excess in all but the highest enzyme concentration.

In the following series of experiments the enzymic formation is studied of volatile compounds from nonvolatile substrates from raspberries. To this end the liquid substrate mixture, buffered at pH 7, is mixed in separate flasks with raspberry

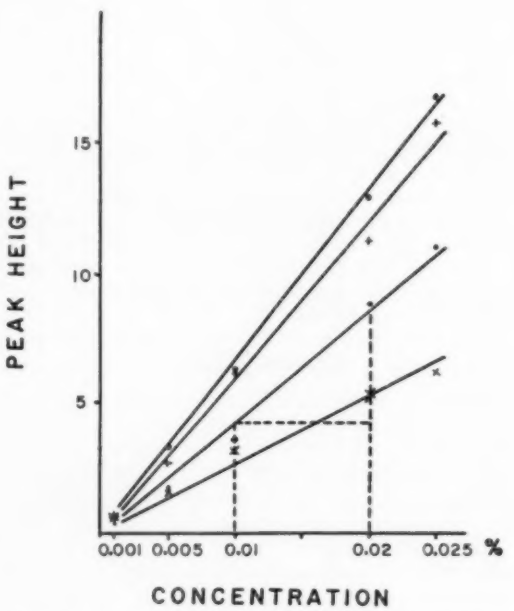


Fig. 1. Peak height on chromatogram of headspace vapor sample versus concentration of compound in water.
×——× iso-propanol, 5 ml; full sensit.
●——● ethylacetate, 1 ml; 1/10 full sensit.
+——+ propionaldehyde, 2 ml; 1/10 full sensit.
○——○ acetone, 2 ml; 1/3 full sensit.

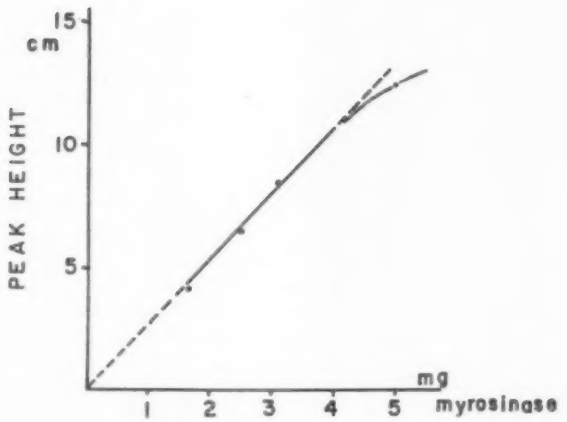


Fig. 2. Peak height of allyl isothiocyanate liberated from sinigrin versus amount of enzyme. Column and detector 100°C, argon flow 66 ml/min; 1/10 full sensit. Other chromatographic conditions as in text.

enzyme (dry powder) and with each of the other enzymes (either dry powder or liquid suspension) mentioned in Table 1. The raspberry substrate and enzyme as well as some of the other enzymes used, had some weak odor of their own; none however, characteristic for raspberries. Chromatograms of vapor samples over these separate components of the reaction mixtures already showed 3–5 small peaks before mixing, as is shown for the raspberry enzyme and substrate in Fig. 3. Thus the peak heights, representing individual compounds from separate substrate and enzyme vapor samples, must be subtracted from the heights of corresponding peaks from the mixed substrate enzyme tests. The resulting adjusted chromatograms show the actual amounts of volatile compounds enzymically released from nonvolatile precursors of these compounds in the substrate mixture.

To make it possible to follow this procedure the flasks for this series of experiments were made up to contain 10 ml liquid substrate mixture, 10 ml buffer + 0.5 g raspberry enzyme, 10 ml buffer + 10 mg of any of the other enzymes (in the case of alcohol dehydrogenase 10 µl of enzyme suspension + 5 mg coenzyme I was added to the buffer), 10 ml liquid substrate mixture + 0.5 g raspberry enzyme, 10 ml liquid substrate mixture + 10 mg of any of the enzymes (in the case of alcohol dehydrogenase 10 µl of enzyme suspension + 5 mg coenzyme I was added to the buffer). All flasks were kept 63 hr at 30 ± 0.5°C, and vapor samples were analyzed after reaching equilibrium at room temperature.

In Fig. 3 three actual chromatograms are shown of the vapor, raspberry precursor, raspberry enzyme, and their mixture. They are drawn as if run at the same time for greater ease of comparison, and the peaks are numbered for later reference in other figures, in text, and in Table 1. Peak Nos. 1 and 2 in Fig. 3 are not mentioned in the table since they are not formed in any of the enzyme reactions. Fig. 4 shows the resulting chromatogram for the experiment with the raspberry enzyme and substrate mixture when the individual compound peaks of the precursor and of the enzyme have been subtracted from those representing the mixture.

Chromatograms of tests with enzymes other than those of raspberry are given in Figs. 5, 6, and 7. This time they are given after subtraction of the substrate and enzyme peaks, and thus directly show the actual amounts of enzymically formed volatile compounds. For easier comparison, two chromatograms are again presented in the same figure. One of the chromatograms in each of these figures represents an experiment with the raspberry enzyme (here reduced in scale by analyzing ½ ml vapor), the other a chromatogram of an experiment with one of the other enzymes. Apart from the enzymes mentioned in Figs. 3 to 7, none of the other enzymes tested in our experiments released any volatile compound from the raspberry substrate with the exception of lipase. In this case only one peak,

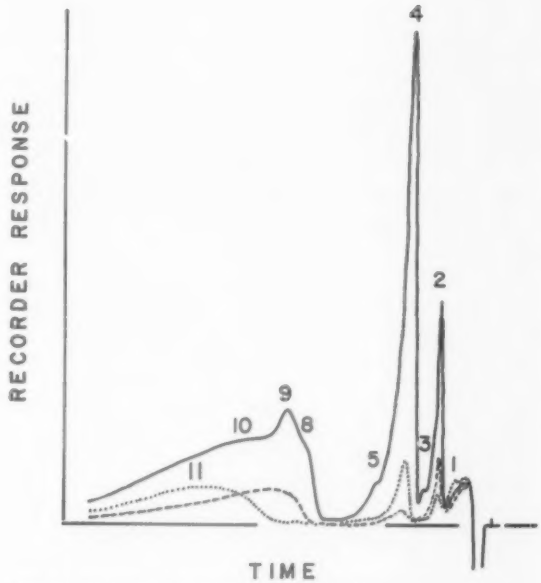


Fig. 3. Enzymatic development of volatile compounds.
——— raspberry substrate mixture with raspberry enzyme.
- - - - - - - - raspberry substrate mixture without enzyme.
..... raspberry enzyme without substrate mixture.
Chromatographic conditions in text. The first positive, rather wide peak following the negative off-scale air peak after the application point, is typical for the apparatus used in our experiments. The phenomenon is not fully understood, but the peak does not represent any compound of the samples.

no. 5, showed in the chromatogram of the enzyme-substrate mixture. No figure is given from this experiment or from experiments with other enzymes of Table 1 in which no formation of volatile compounds was observed.

Finally, experiments are recorded with the dry, powdered, raspberry substrate mixture to compare heated and unheated enzymes. Suspensions of 0.5 g of raspberry enzyme in buffer were heated 10 min in closed flasks in boiling water, cooled,

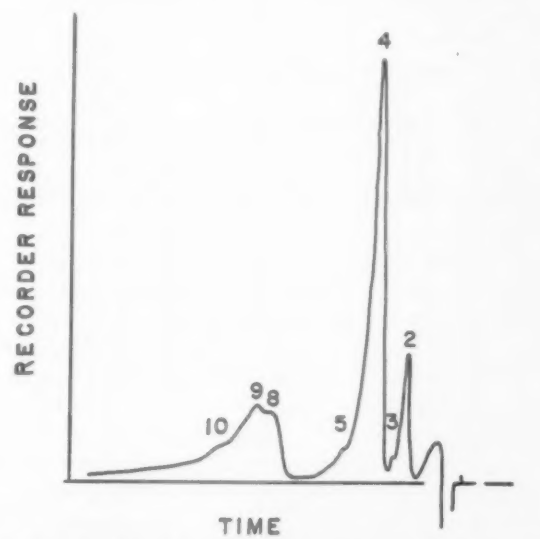


Fig. 4. Net formation of volatile compounds of experiment represented in Fig. 4. For the first positive peak see caption Fig. 3.

and left to reach equilibrium. The flasks were opened, and 5 g of powdered substrate were added. Duplicate runs with mixed enzyme-substrate samples were treated in the same way without heating the enzyme. Reaction mixtures were incubated and vapor samples analyzed as described. The results of a typical run are given in Fig. 8, where the activity of the unheated enzyme is compared with that of the heated enzyme.

DISCUSSION AND CONCLUSIONS

Gas-liquid chromatographic analysis of headspace vapor under our experimental conditions gives very nearly straight-line relationships when peak heights on chromatograms are plotted against the concentration of the compounds in water (Fig. 1); it was not necessary to measure the peak area to establish such a relationship. For each of the four compounds, representing different types of chemical properties, a doubling of the concentration nearly doubled the peak height. This technique of headspace vapor analysis is then applied to the quantitative analysis of enzymes. As seen in Fig. 2, the heights of the peaks of allylisothiocyanate produced by myrosinase are closely correlated with the amount of enzyme in the reaction mixture.

These results clearly justify the application of gas-liquid chromatography for the quantitative study of enzyme-substrate reactions. They also show that, in an aqueous solution already containing certain amounts of volatile compounds, the amounts of every additional formation of these compounds can be found by subtracting the peak heights of the original solution from the peak heights observed after the increase in concentration has taken place.

There is some reason to elaborate on the experiments discussed. In these experiments the straight-line relation between the amount of the compounds in the headspace vapor and the concentration of these compounds in their solution will be found only over certain concentration ranges. More easily, however, it will be overlooked that the detector of the gas chromatograph used shows linearity with regard to the concentration of a compound in the carrier gas over only a limited range; the range of linearity depends on the type of detector and may even differ with other parameters. It therefore should always be realized that such tests as described are strictly necessary when conclusions about enzyme activity tests are based on quantitative or semiquantitative analysis of headspace vapors by gas-liquid chromatography.

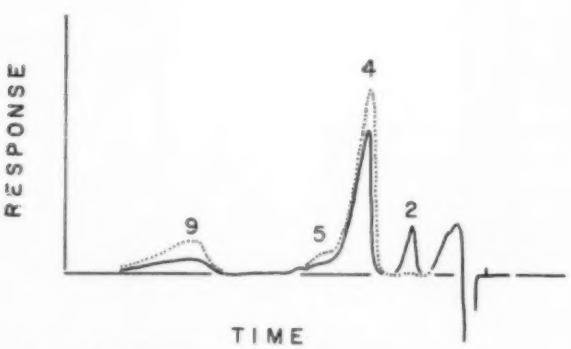


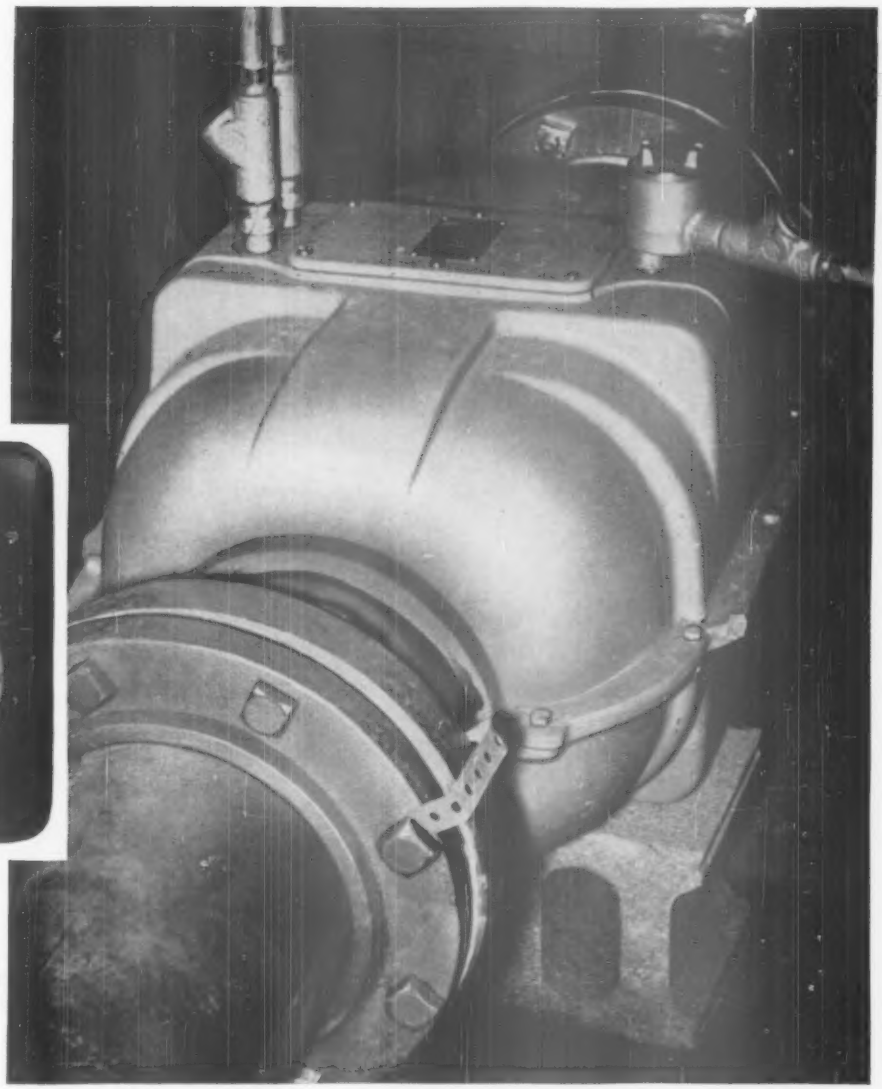
Fig. 5. Net formation of volatile compounds.
——— raspberry substrate mixture with raspberry enzyme (sample ½ ml).
..... raspberry substrate mixture with cellulase (enzyme No. 3, Table 1).
Other chromatographic conditions in text. For the first positive peak see caption Fig. 3.

At least 7 volatile compounds are formed when enzymes from raspberry act on the nonvolatile substrates of the same fruit (Figs. 3, 4). If any doubt is felt as to whether the formation of these volatile compounds is actually due to enzyme activity, such doubt should be dispelled by the heat inactivation experiment (Fig. 8). Non-excessive heat treatment of the raspberry enzyme, with care to prevent any escape of volatiles present, is now seen to eliminate the formation of volatile compounds as is observed with the unheated enzyme sample. Minor differences in the over-all pattern are due to differences in the substrate mixture and to differences in flow rate and temperature during analysis.

In the experiments with non-raspberry enzymes, the amounts of the enzyme added to the substrates, the pH at which the reactions were studied, and other variables were selected arbitrarily. It should be realized that these enzymes are themselves intricate mixtures of enzymes. Even if we have information on the character and the activity of some particular enzyme in these enzyme mixtures, and indicate the enzyme according to the substrate of that particular enzyme, nothing is known about the character, pH optimum, or amount of the enzyme in the mixture that is actually acting on some unknown precursor of volatile compounds in the substrate mixture. This can be seen in the experiment where alcoholdehydrogenase + coenzyme I was added to the substrate mixture. When the dehydrogenase was incubated with raspberry substrates, volatile compounds indeed formed (Fig. 7). However, when in separate experiments the alcoholdehydrogenase plus coenzyme was added to dilute buffered solutions of some simple alcohol, no trace of any formation of volatile compounds could be seen, presumably because the equilibrium of the alcohol-carbonyl reaction is strongly in favor of the alcohol (Baldwin, 1952). The formation of volatiles observed when the enzyme is added to the raspberry substrates, therefore, should not be attributed to the alcoholdehydrogenase proper, acting on some simple alcohol, but to some other enzyme in the preparation acting on unknown precursors.

In the experiments in which enzymes other than the raspberry enzyme were added to the substrate mixture, the ratio of the amounts of the individual volatiles formed differ from each other and from the ratio of the amounts in the raspberry enzyme experiments. This is convincingly shown in Fig. 5, where it is seen that the enzyme cellulase (no. 3, Table 1) produced more of the volatile compounds represented by peak nos. 4, 5, and 9 than did the raspberry enzyme. The raspberry enzyme, on the other hand, produced the volatile of peak no. 2, a reaction that could not be promoted by the cellulase. Figs. 6 and 7 show more examples of these differences in peak ratio. In the lipase experiment, for which no figure is given,

▲ Foxboro Dynalog electronic receiver records flow passing through Magnetic Meter — logs total in gallons per minute.



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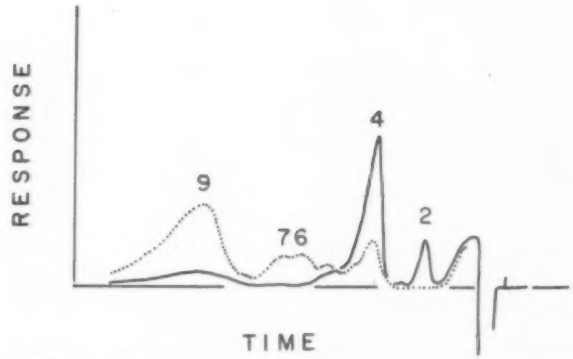

Fig. 6. Net formation of volatile compounds.
——— raspberry substrate mixture with raspberry enzyme (sample ½ ml).
..... raspberry substrate mixture with β-glycosidase (enzyme No. 2, Table 1).
Other chromatographic conditions in text. For the first positive peak see caption Fig. 3.

the only volatile compound formed was the one showing in peak no. 5, whereas with the raspberry enzyme several peaks are far more pronounced than no. 5.

The complexity of the substrate as well as of the enzymes investigated allows very conservative conclusions only. The results, however, do answer one important question in the field of the formation of volatile compounds in ripening fruit: whether one single enzyme (e.g., a glycosidase) acting on different precursors (e.g., glycosides) is responsible for this formation, or whether a number of different enzymes are acting on one or more precursors of volatile compounds. The ratio differences in the formation of volatile compounds, pointed out above, strongly favor an explanation by which different enzymes acting on different precursors are held responsible for the formation of volatile compounds in ripening fruit.

Two other conclusions can be drawn from the results.

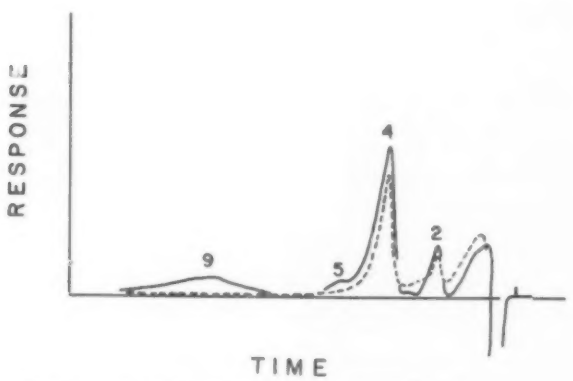

Fig. 7. Net formation of volatile compounds.
——— raspberry substrate mixture with raspberry enzyme (sample ½ ml).
..... raspberry substrate mixture with alcohol dehydrogenase and coenzyme (enzyme No. 4, Table 1).
Other chromatographic conditions in text. For the first positive peak see caption Fig. 3.

In Fig. 6 it is seen that the peaks of two incompletely separated compounds (peak nos. 6 and 7) show in the chromatogram of the test with β-glycosidase (enzyme no. 2, Table 1). These volatile compounds were not produced in raspberry enzyme experiments, and it seems reasonable to deduce that precursors of volatile compounds are present in the raspberry substrate mixture on which no enzyme in the raspberry enzyme preparation is acting.

It can also be concluded that the raspberry substrate mixture contains no mustard oil thioglucoside, since, although the myrosinase from yellow mustard seed flour produced readily detectable amounts of allyl isothiocyanate from sinigrin, no such volatile could be observed when the same enzyme was acting on the raspberry substrates.

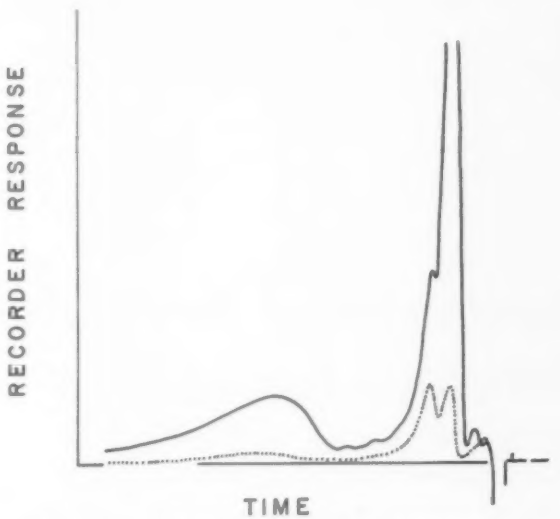

Fig. 8. Enzymatic development of volatile compounds.
——— raspberry substrate mixture (powder) with raspberry enzyme.
..... the same, with heated enzyme.
Column and detector 75°C, argon flow 60 ml/min; sample ½ ml. Other chromatographic conditions in text. For the first positive peak see caption Fig. 3.

No mention has yet been made of the production of odors in our experiments. Only when the raspberry enzyme was made to interact with the raspberry substrates was a strong odor of raspberries developed. In none of the experiments with other enzymes were any significant changes from the flat, weak, and somewhat unpleasant residual odor of the substrate mixture observed. It is, of course, possible that an increase or change in odor would have been observed if larger amounts of the non-raspberry enzymes had been added to the substrates, and it is equally possible that a suitable mixture of enzymes other than raspberry could be found to produce the actual odor of the fruit even if these enzymes are not capable of doing so separately. Care was taken, however, in the description of our experiments and in the discussion of their results, to speak of volatile compounds only. The enzymic development of the characteristic rasp-

berry odor ran parallel with the formation of the volatile compounds studied in our experiments, but the actual relation between odor and volatile compounds was not investigated.

The study is thought to be of particular interest in showing the possibilities for more detailed investigations of the many processes where volatile compounds or odors are formed by enzymic action; the ripening of fruit where a great variety of such volatiles are formed and odor tends to accumulate is only one of these processes. Enzyme and nonvolatile substrate mixtures containing precursors of volatile compounds are readily prepared from different parts of fruit, and it was clearly shown that the formation of volatile compounds and odor results from their interaction.

Gas chromatographic analysis of headspace vapors proved useful for quantitative determination of small amounts of volatiles in aqueous solutions and of enzymes producing such compounds. The method is thus shown to be a valuable tool in fruit ripening studies, especially when the difficulties encountered in the identification of individual compounds have been overcome.

ACKNOWLEDGMENTS

The work reported here formed part of a research program of the Pioneering Research Division at the Quartermaster Research and Engineering Center, Natick, Mass., during a Research Associateship awarded by the National Academy of Sciences-National Research Council. The help of Dr. Elwyn T. Reese in correcting the English is gratefully acknowledged.

REFERENCES

Bailey, S. D., M. L. Bazinet, J. L. Driscoll, and A. I. McCarthy. 1961. The volatile sulfur compounds of cabbage. *J. Food Sci.* **26**, 2.

Baldwin, E. 1952. Dynamic aspects of biochemistry, 2nd Ed., Cambridge (Engl.), p. 194.

Hewitt, E. J., T. Hasselstrom, D. A. M. Mackay, and K. S. Konigsbacher. 1960. February 9. Natural flavor of processed foods. U. S. Pat., 2,924,521.

Hewitt, E. J., D. A. M. Mackay, K. Konigsbacher, and T. Hasselstrom. 1956. The role of enzymes in food flavors. *Food Technol.* **10**, 487.

Reese, E. T., R. C. Clapp, and Mary Mandels. 1958. A thioglucosidase in fungi. *Arch. Biochem. Biophys.* **75**, 228.

Determination of Moisture Equilibria in Dehydrated Foods

(Manuscript received May 7, 1961)

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SUMMARY

A method of evaluating the relations between equilibrium relative humidity (ERH) and moisture content by vapor-pressure measurement has been used to give data on dehydrated foods. The technique is rapid and allows several determinations to be carried out on the same sample at various moisture levels. The method also has potential application as a rapid moisture-determination method giving results after observation of 1 hr. ERH is much more indicative of the behavior of the food with respect to its moisture than is the moisture content. Data for a variety of accelerated freeze-dried foods have been obtained that are applicable to dehydration and storage problems and have indicated that the apparatus could be very suitable for further study of the behavior of water in dried foods.

The relation between a food product and its moisture content is of great value in predicting the behavior of the food in storage. Since it is especially important with foods of a hygroscopic nature, it is essential, when storage problems of dehydrated foods are being studied, to have data on the behavior of the water that remains in the food. Moisture contents below certain levels inhibit the growth of microorganisms. Similarly, reduction of the moisture content of dehydrated foods retards the Maillard, or browning, reaction associated with the spoilage of dehydrated foods.

The water in a hygroscopic material, at a certain moisture content, produces a vapor pressure, P, that is less than the saturated water-vapor pressure of pure water, P_o, at the same temperature as the material. The ratio P/P_o is defined as the water activity, A_w, of the foodstuff. The water activity of the food will vary with temperature, but the variation is slight and is not important over the normal range of storage temperatures for foods. The value 100 (P/P_o) is the equilibrium relative humidity (ERH) of the food, and is numerically equal to the water activity of the food expressed as a percentage. Whereas water activity is regarded as a property of the hygroscopic material itself, ERH is regarded as a property of the atmosphere in equilibrium with the hygroscopic material.

It is the ERH of a foodstuff that determines whether it will gain or lose moisture in a particular environment, and so this property is more relevant to storage behavior than is moisture content. The lowest water activity at which microorganisms are able to grow depends somewhat on the nature of the medium, but approximate minimum limits may be defined. Most bacteria are inhibited at $A_w = 0.95$. Some osmophilic

yeasts are, however, able to grow at $A_w = 0.61$. Molds grow readily at $A_w = 0.75$–0.80. The significance of these figures may be realized when they are considered in relation to the water activities of some foods: in fresh beef, $A_w = 0.993$; in fruit cake, $A_w = 0.73$–0.85; and in jams, $A_w = 0.70$–0.83.

Compilation of ERH data for dehydrated foodstuffs is generally a rather slow process with most existing methods. Modification of an existing technique gave a method that permits reasonably rapid measurement of such data.

EXPERIMENTAL PROCEDURE

The method used was a development of the manometric technique of Makower and Myers (1943), who observed the vapor pressure exerted by samples of food at different moisture levels. Whereas the original method employed a different sample at each moisture level, an improvement allowed a whole range of observations to be carried out on one sample. Instead of requiring moisture determinations of a complete range of samples it was now sufficient to obtain a single reference moisture content, from which each moisture level could be calculated.

The apparatus is shown in Fig. 1.

The sample to be examined was ground to a suitable particle size and allowed to equilibrate to a moisture content of approx 20%. A vacuum-oven moisture determination was carried out on a portion of this sample, and, if it contained fat, a Soxhlet determination was made. Approx 5 g of the sample were weighed into a sample thimble together with a small thermometer, and connection was made to the main apparatus by a ground-glass joint. The sample thimble was then immersed in a flask of liquid oxygen, which effectively sealed the moisture in the sample and prevented any evaporative loss during subsequent evacuation of the apparatus.

The whole system, with taps A, B, C, D, E, and F open, was then evacuated to a moderately low pressure of the order of 10^{-2} mm Hg. When a steady low pressure has been attained, tap D was closed, bringing the oil manometer into operation. The sample was allowed to equilibrate to room temperature, in this case, 18–21°C. The oil level in the manometer was then deflected by the increase in pressure in the sample arm; after an hour, equilibrium was reached and the difference in the pressure reading of the manometer noted. This deflection was caused by the vapor pressure of the sample together with air trapped in the sample during the freezing process. The error due to the latter was measured by freezing the sample again, when all the condensable vapor re-condensed, leaving residual air pressure. This error was subtracted from the initial deflection to give the vapor-pressure value. From this vapor-pressure value, the ERH could be calculated.

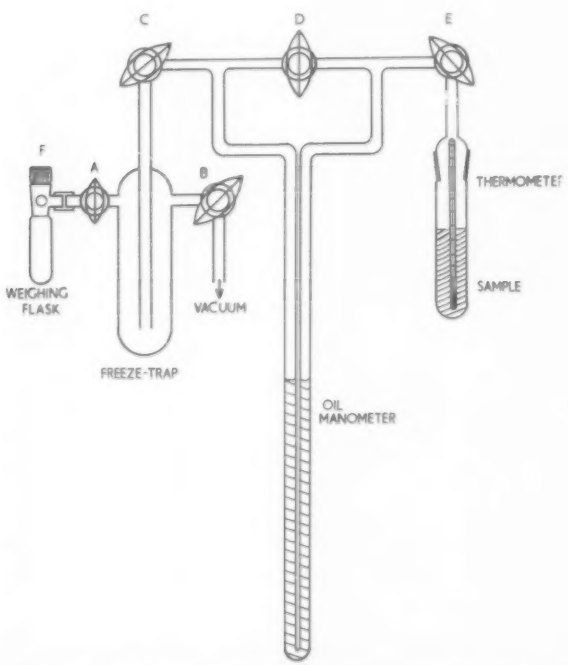


Fig. 1. Apparatus for measuring the vapor pressure of AFD products at different levels of dryness.

The initial point of the curve relating ERH to moisture content had now been obtained, and it now remained to complete the curve with observations at other moisture levels. This was carried out on the same sample with the whole system under vacuum. A liquid-oxygen flask was placed around the freeze-trap, and taps A, B, and F were closed. Tap D was opened so that moisture could distill from the sample into the freeze-trap. The evacuated weighing flask was detached from the rubber tubing connecting it to Tap A, and weighed. After a satisfactory amount of water had been removed from the sample, tap D was again closed and the sample allowed to attain its new moisture equilibrium. The weighing flask was then re-attached to tap A, and the side-arm was evacuated. Taps B and C were closed, and taps A and F were opened. By moving the liquid oxygen flask from the freeze-trap to the weighing flask, the condensate in the former distilled, under vacuum, into the small tube. When the transfer was complete, taps A and F were closed and the weighing tube was removed and re-weighed.

From the weight of water removed from the sample and the initial weight of the sample, the new moisture content was calculated. The process was repeated, the sample being progressively dehydrated and the removed water being accumulated under vacuum in the weighing flask until enough observations had been made. It is possible to dry down to 0.5% moisture content with this vacuum distillation technique.

DISCUSSION OF PROCEDURE

Several technical difficulties arise in observation of the primary drying curve of a foodstuff. Drying is slow since it is difficult to apply sufficient heat to the sample and duplicate the AFD process. Nevertheless this type of study could be carried out with only slight modification of the technique. It has proved more convenient, in this instance, to study a secondary drying curve.

In studying materials of a homogeneous nature it would be admissible to use samples as small as 1 g but since dehydrated foods are predominantly heterogeneous in character a larger sample, approx 5 g, was usually chosen. Although the vapor pressure of a material is independent of its particle size, the latter does play a considerable part in the rate of equilibration. This is influenced by the surface area of the sample and so it is advantageous to grind the sample as finely as is compatible with the procedure. It is not always practical to grind the material too fine since subsequent evacuation of the apparatus may lead to loss of particles from the sample thimble. A compromise must therefore be made regarding particle size and the nature of the sample.

In order to relate moisture content to ERH, a standard reference moisture method must be selected. Moisture-content values vary considerably, depending on the determination method, but the vacuum-oven technique of heating for 5 hr at 70°C under vacuum appears to be an acceptable standard method. This

method was used to obtain the reference moisture content of the initial sample. During this method of moisture determination, volatile gases are driven off in addition to the water in some cases, and a slight error is introduced. This is increased slightly during the ERH determination since there is no simple way of distinguishing between water and other condensables. At 20°C, however, this additional effect should be a comparatively minor one. The total effect of these errors displaces the isotherm downward so that it intersects the moisture axis at a lower point than otherwise. The ordinates called, for convenience, "moisture content" are therefore actually a measure of the condensable gases in the dried food. For most practical purposes, however, they may be regarded as equivalent to the moisture-content values.

The accuracy of moisture determination depends greatly on efficient handling of samples; in this case they were weighed immediately after they and the sample for vapor-pressure observation were taken. In this way, a minimum deviation from equilibrium conditions was achieved and, since the samples were also at high ERH levels, they were less susceptible to variation than very dry samples would have been. Reproducibility to the nearest 0.05% moisture content was normally obtained.

In all manometric methods of determining vapor pressure of small samples, the volume of the sample side of the manometer must be kept to a minimum. This has been done as far as possible in the improved apparatus; narrow-bore tubing has been used for all connections, and the volume of the sample side has been reduced to approx 20 cc.

The degree of vacuum in the system is not critical, but a constant low pressure must be maintained. A pressure of 10^{-2} mm Hg has been found quite satisfactory; lower pressures than this accelerate equilibration and give more rapid distillation within the apparatus, but these advantages do not completely outweigh the added difficulties associated with high-vacuum techniques.

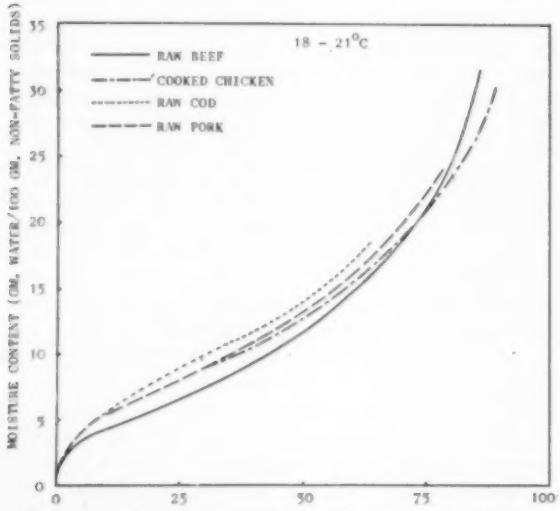


Fig. 2. Desorption curves at 18–21°C for raw beef, cooked chicken, raw cod, and raw pork.

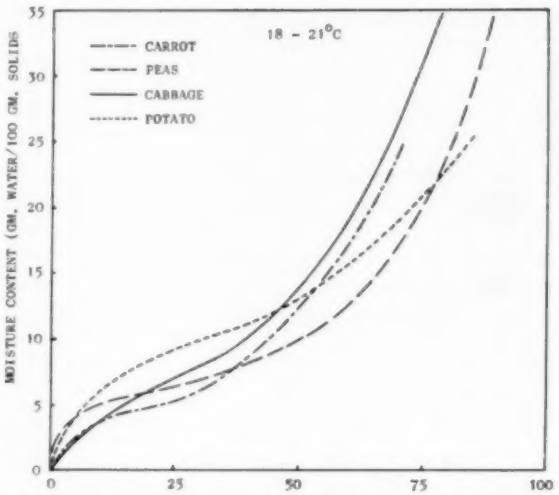


Fig. 3. Desorption curves at 18–21°C for carrot, peas, cabbage, and potato.

The fluid chosen for the manometer was a low-vapor-pressure oil, Apiezon B. This was used instead of mercury to introduce a magnification factor (1 mm Hg was equivalent to 15.7 mm oil). The manometer can be read to the nearest 0.2 mm oil though more accurate reading could be achieved with a cathetometer. The total deflection, i.e., the vapor pressure of pure water at 20°C, is 27.5 cm oil; thus, a change of 0.2 mm oil at 20°C represents a vapor-pressure change corresponding to 0.07% ERH.

ERH is independent of temperature over the restricted range of observation. Since vapor pressure is extremely temperature-dependent, it would be very convenient to carry out observations at high temperatures. At 37°C the full-scale deflection of the manometer is 73.6 cm oil, and this expansion of the scale over that at 20°C would lead to increased accuracy of reading. Such a temperature could be used for observations over the range of ERH covered in this

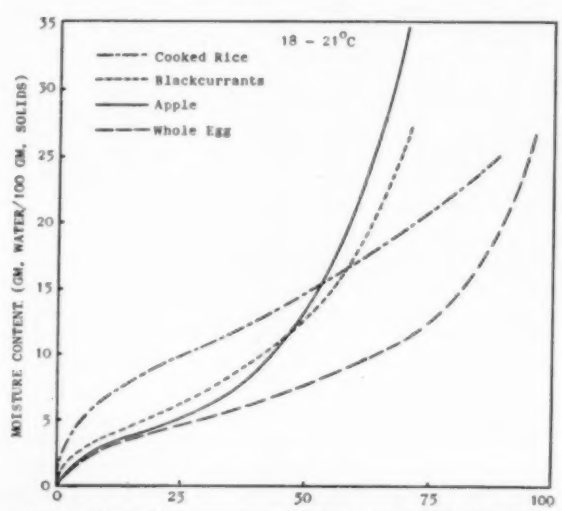
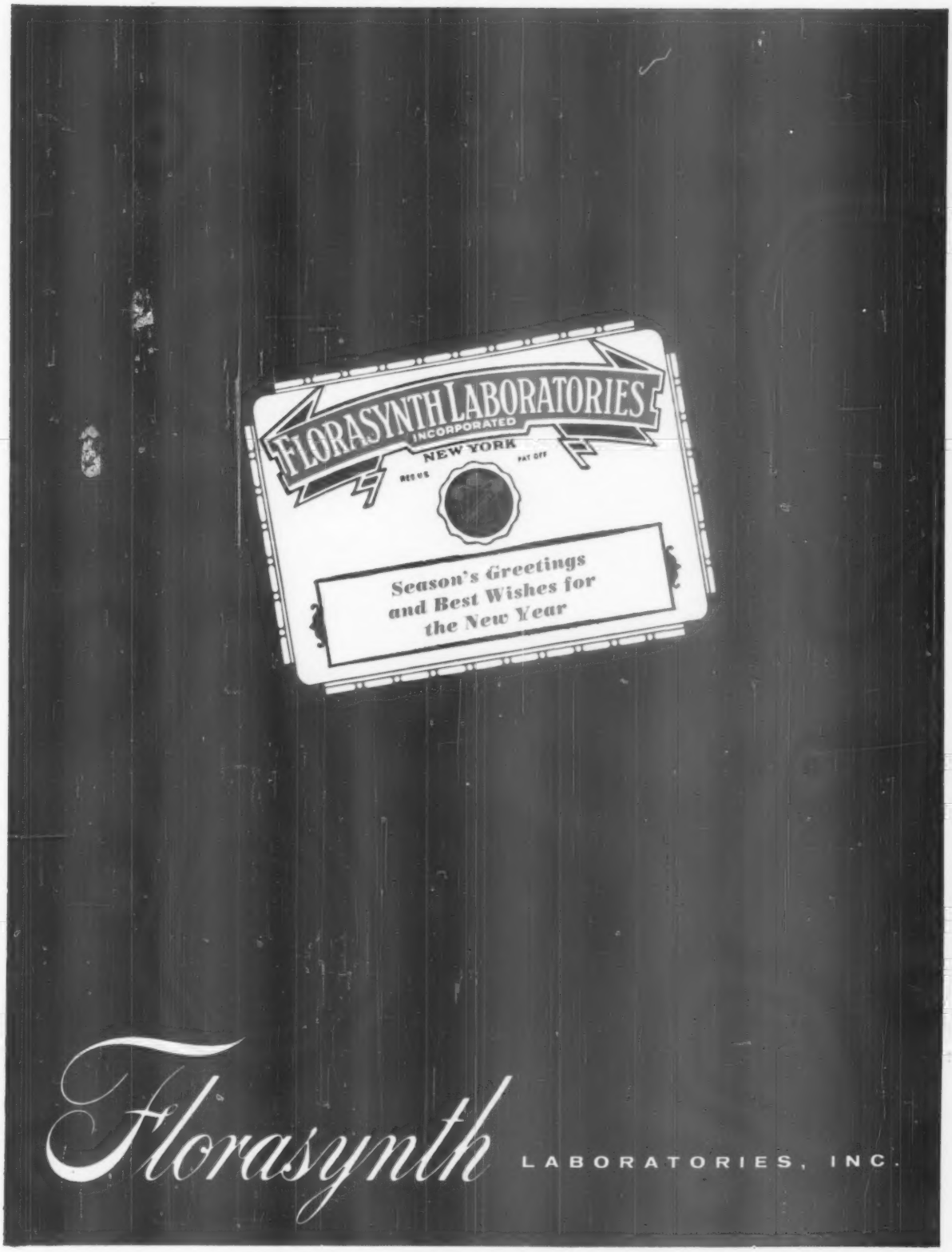


Fig. 4. Desorption curves at 18–21°C for cooked rice, blackcurrants, apple, and whole egg.



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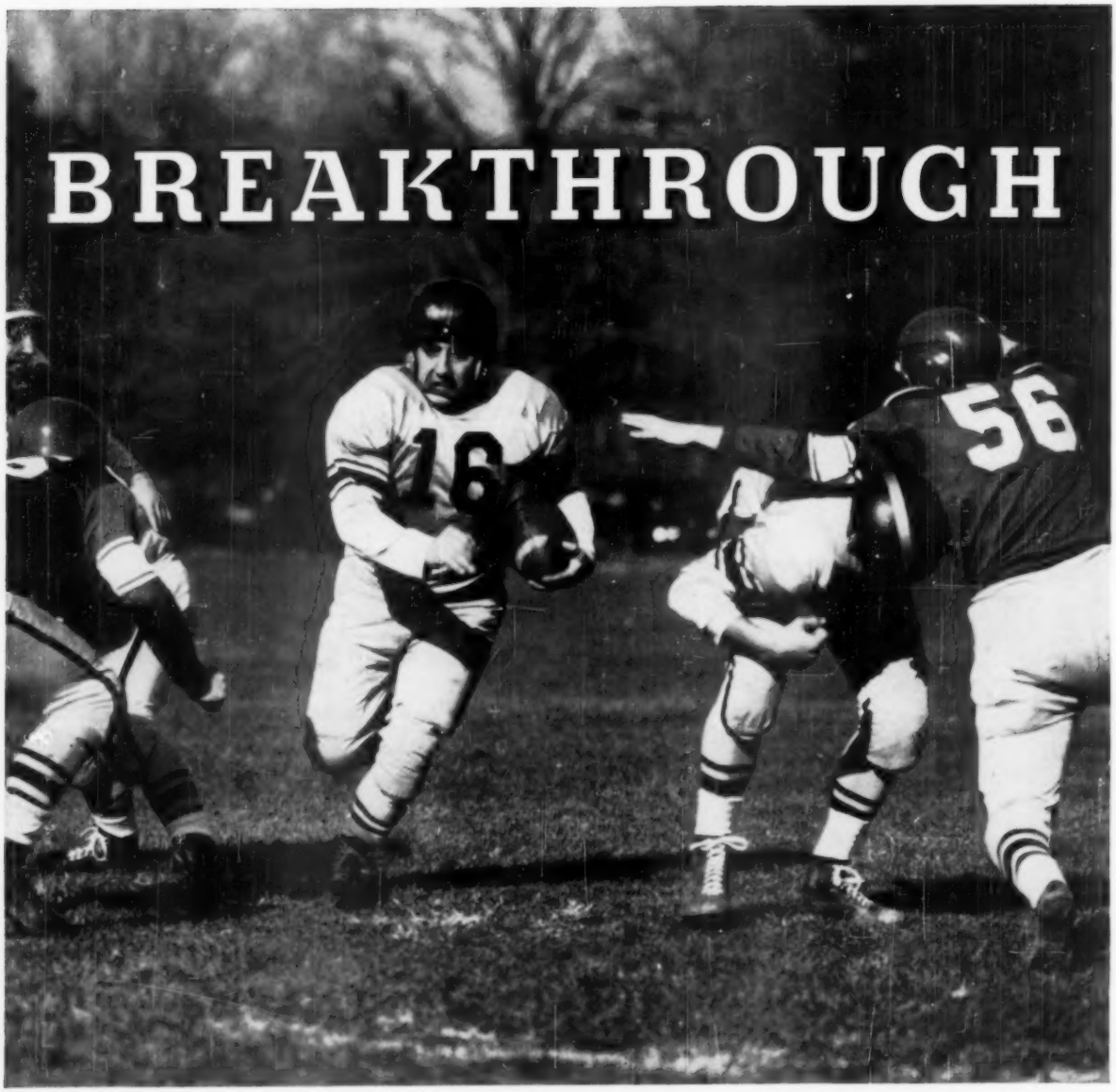

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study only if the apparatus was maintained at a temperature such that the vapor pressure of the sample did not exceed P_o at any point in the manometer arm. If P_o is exceeded, local condensation will occur and the true vapor pressure of the sample will not be registered. Since temperature has such an influence on the vapor pressure of the sample, it was essential that the temperature should be measured accurately and a small thermometer was placed in the sample tube to ensure good thermal contact.

In most cases equilibrium was reached between sample and its surroundings after approx 1 hr, so that any changes in the food that might affect its water-binding properties were kept to a minimum. This short observation time is a great advantage over the weight equilibrium methods for measuring ERH, with which the observations may require several hours or even weeks.

RESULTS AND DISCUSSION

Desorption isotherms relating moisture content and ERH were compiled from a variety of foods, including meats, fish, vegetables, and fruits, all dried by the accelerated freeze-drying process at the M.A.F.F. Research Establishment, Aberdeen, Scotland. All materials examined except the chicken and rice were uncooked, though the vegetables were cooked some during pretreatment. Each isotherm was compiled from about twenty observations at different moisture levels.

Many of the foods contained fat, and the general effect of fat was noted. The vapor pressure of fat in meats was almost negligible and played little or no part in the total vapor pressure of the food. All weights, therefore, were referred to a fat-free basis, enabling comparison of samples containing different amounts of fat. Presence of fat, however, does slow equilibration, tending to coat the particles of the sample and prevent free transfer of moisture.

The sigmoid isotherms consist of two components. At low ERH values the water is tightly bound, and is claimed (Salwin, 1959) to represent a statistical monolayer. The precise ERH corresponding to this monolayer varies with composition, being approx 20% for starchy foods, 11% for protein foods, and 6% for sugar-protein foods (Salwin, 1961). Above this ERH multilayer, adsorption predominates and continues until free-water equilibrium is approached. It is important in dehydration study to know at which level the tightly bound monomolecular layer of water is encountered since this is increasingly difficult to remove during drying.

The described method made it possible to obtain ERH values at very low moisture contents, whereas by existing methods this was very difficult because of inaccuracy of moisture determination of dry samples. It was observed that the curves tended toward the origin, and it was considered reasonable to extrapolate them through that point. Zero moisture content could therefore be defined as that condition of the material when vapor pressure is zero at observation temperature. This definition, however, refers only to the free water that is active and not so bound that it may not exert vapor pressure.

Several theoretical methods exist for prediction of the behavior of moisture in solids. The most practical of these is probably the equation by Henderson (1952), which permits derivation of a complete isotherm from a few points and the knowledge of certain constants characteristic of a given material. The equation is stated thus:

$$1 - \phi = e^{-kTM^n}$$

where ϕ = water activity
T = absolute temperature
M = moisture content (dry basis)
k, n = constants characteristic for a given material

This may be written as,

$$\log_e [-\log_e(1-\phi)] = \log_e k + \log_e T + n \log_e M$$

A plot of $\log_e [-\log_e(1-\phi)]$ against $\log_e M$ at constant temperature should therefore produce a straight line. Unfortunately the equation produces the ideal straight-line relationship in only a very few cases, and the inadequacy of such an equation applied to most foods is shown in Fig. 5, where the isotherms obtained by observation are expressed in terms of the Henderson equation. It may be noted, however, that for rice and chicken the straight line is nearly obtained. Nevertheless the complexity of most foods makes it advisable to examine their desorption isotherms as in Figs. 2, 3, and 4.

In addition to providing information on the ERH of foods the method has a possible application as a rapid moisture determination method. For this a calibration curve would be required for each food. A determination of the vapor pressure, taking a period of about 1 hr, would give a value that could be directly related to the moisture content of the sample. This would of course use, as a reference for the calibration curve, the vacuum-oven technique of moisture determination. Such reference could, however, be elimi-

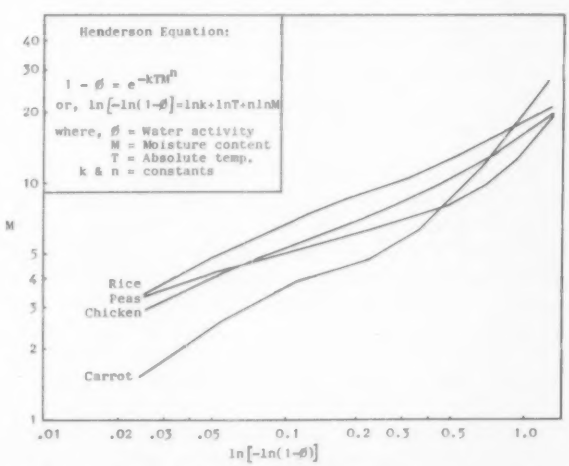

Fig. 5. Prediction of moisture equilibria by Henderson equation.

nated completely if the moisture content of the food was expressed in terms of water activity, which property is, in fact, the more important in deciding the behavior of the food with respect to its moisture.

ACKNOWLEDGMENTS

The author acknowledges the assistance of D. Winton in compilation of much of the equilibrium data appearing in this paper.

REFERENCES

Henderson, S. M. 1952. A basic concept of equilibrium moisture. *Agr. Eng.* **33**, 29.

Makower, B., and S. Myers. 1943. A new method for the determination of moisture in dehydrated vegetables. *Proc. Inst. Food Technologists 4th Conf.* p. 156.

Salwin, H. 1959. Defining minimum moisture contents for dehydrated foods. *Food Technol.* **13**, 594.

Salwin, H. 1961. Data presented during National Research Council, Conference on Freeze-Drying of Foods, April 1961.

A Macrophotographic Technique for the Quantitative Determination of Marbling and Its Relative Distribution in Meat

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(Manuscript received June 10, 1961)

SUMMARY

A macrophotographic technique was developed by which the amount of marbling or intramuscular fat and its relative distribution in meat could be expressed quantitatively. High-contrast positive transparencies were developed from negative photographs of 30 rib steaks classified into three marbling groups from independent evaluations by three judges. A prototype optical device was constructed to measure the amount of light transmitted by each positive transparency. The amount of transmitted light was correlated with the total amount of ether-extractable fat. The relative distribution of marbling was determined by spot-scanning the transparency, and the standard deviations of the transmittance scans was used as a measure of the marbling distribution. Results indicate that the technique is able to detect large differences in marbling.

Wang *et al.* (1954), Cover *et al.* (1956), Palmer *et al.* (1959), and Wellington and Stouffer (1959) have shown that the amount and relative distribution of marbling or intramuscular fat in a cut surface of meat gives the consumer some indication of its eating qualities. The exact role of marbling in meat quality remains undecided, but it is believed to enhance the factors of juiciness, flavor and tenderness.

At present the amount of marbling visible in the cut surface between the twelfth and thirteenth ribs of beef carcasses is being used as one of the factors in estimating the final grade. Objective evaluations of marbling are needed for research purposes, and if made practical may be applicable in commercial meat grading. Therefore, there is a need for a technique or test by which the amount of intramuscular fat present can be expressed quantitatively by objective means.

Until recently no quantitative objective methods for measuring marbling have been available. Schoonover and Stratton (1957) developed a photographic grid technique for recording the amount of bone, fat, and muscle on a cut surface of meat. Blumer and Fleming (1959) adapted a bacteriological counter for use in expressing the amount of marbling present in beef cuts. Lewis *et al.* (1958) sectioned and fixed isolated beef muscles and estimated marbling with photomicrographic methods. Orme *et al.* (1958) expressed the total marbling in beef cuts in terms of specific gravity.

This study was made to develop an accurate, rapid technique for objective estimation of marbling and its relative distribution on the cut surfaces of beef ribs.

EXPERIMENTAL PROCEDURES

Thirty beef rib steaks *(Longissimus dorsi)* were classified subjectively and independently by three judges into three groups according to the amount of surface intramuscular fat present. Classification into the three groups was based on the official U.S.D.A. twelve-point marbling-score system as illustrated by Wellington and Stouffer (1959). Samples having slight and trace amounts of marbling were allocated to group A, moderate and modest amounts composed group B, and abundant and moderately abundant amounts made up group C.

To establish a relative distribution index for marbling, a subjective distribution scoring system was established with a 7-point scale (7 most uniform distribution, and 1 least uniform).

Photographic technique. A 35-mm single-reflex camera was used to obtain the original negatives of the sample. Ansco Supreme film A.S.A. 32, was used. The lighting source was two No. 2, 150-watt 3,400°K. photoflood lights placed at a distance of 2 ft away and 6 in. above the sample. To eliminate uneven light distribution on the sample surface, a double-thickness acetate-paper cone was constructed and placed over the sample with the sample located centrally at its base, and the camera lens above the small apex of the cone.

A Kodak No. 6 green filter was placed between the camera lens and the cone apex to eliminate any difficulties that might result from variation in the color of the sample.

To obtain repeatability and standardization of film development, a 10-in. calibrated gray scale was photographed with the sample. Fig. 1 illustrates the photographic apparatus used in obtaining the original negatives.

With the apparatus described, an exposure of 1 sec. at an "f" stop of 6.3 provided negatives with accurate detail and

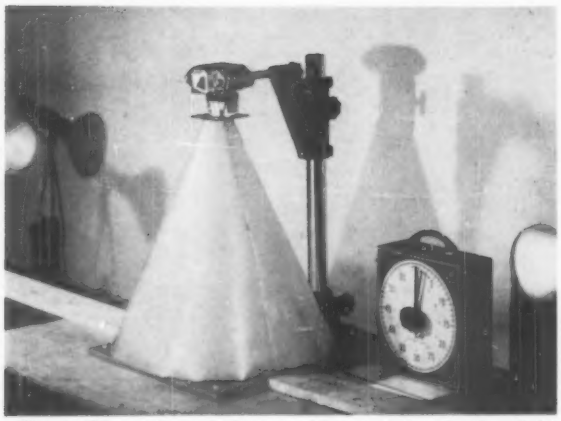

Fig. 1. Illustration of photographic apparatus showing light source, cone, camera, and timer.

medium contrast. Fig. 2 illustrates an original negative photograph of the sample.

The following stage required the processing of high-contrast positive transparencies of the original negatives. A Kodalith Ortho, type 3, high-contrast film was exposed for 9 sec at an "f" stop of 11 or until a clear break point was established between the 7th and 8th calibration of the graduated gray scale, or to a point on the gray scale that exhibited a reflection density of 0.75. The processed transparencies were observed for any outstanding defects and then mounted in 2×2-in. slide covers. Fig. 3 illustrates a print obtained from a high-contrast positive transparency.

Throughout the photographic process, film magnifications were kept constant, a 5:1 reduction from the original sample size provided a workable transparence.

Quarter-inch-thick samples were removed from the photographed area, homogenized in a Waring blender, and dried, and the fat was extracted with ether (A.O.A.C. 1950).

Development of optical device. A prototype optical device was constructed that has a point source of light, a double convex lens, a film holder, and a light-recording instrument. A 6-V car battery provided a constant light source. The double convex lens, which was placed 42.5 cm from the light source, had a diameter of 7.5 cm, a focal length of 24.8 cm, and a speed of 3.17. A film holder was placed 5 cm from the lens and centered so that parallel light rays emerging from the lens passed unobstructed through the transparency. The detector head of a Densicron light-detecting instrument was placed 54.0 cm from the lens. The orifice of the detector was positioned so that it would pick up all the transmitted light.

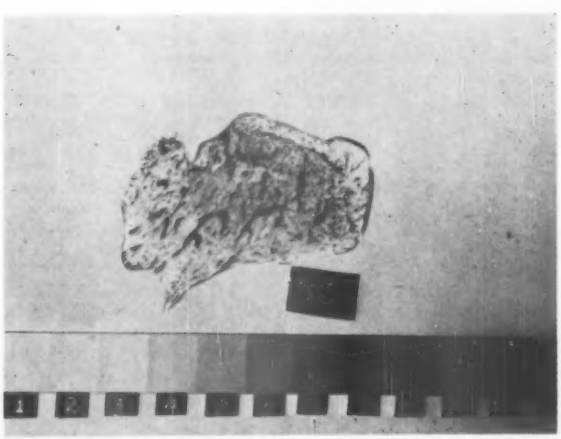

Fig. 2. A print of original negative of sample showing position of calibrated gray scale.

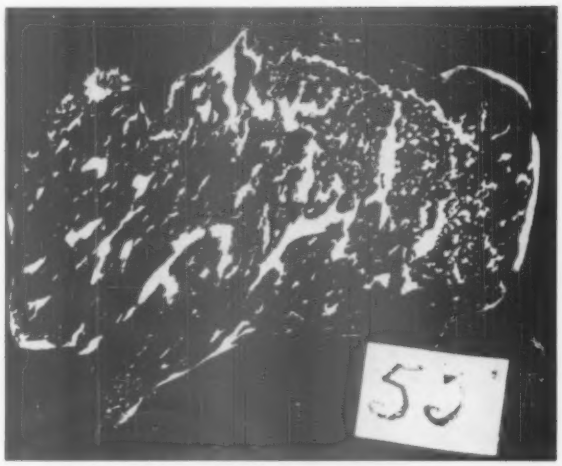

Fig. 3. A print of high-contrast positive transparency.

The percentage of light transmitted was then recorded on the Densicron scale. Fig. 4 illustrates the optics of the recording instrument described above.

In measuring the amount of light transmitted through the sample transparency, a black standard mask of known area and a piece of developed Kodalith film were placed in the optical path of the instrument. The scale on the Densicron was then standardized at a 100% transmission or an O.D. of 0.00. The sample film was then placed in the film holder covered by the standard area mask, and the amount of transmitted light was recorded. This procedure was repeated four times on the sample, and an average value was calculated.

To determine the distribution of marbling, light transmittance values were determined for 9 different positions on the print. The standard mask had an aperture $\frac{3}{16}$ in. in diameter, which was scanned horizontally and vertically over the sample.

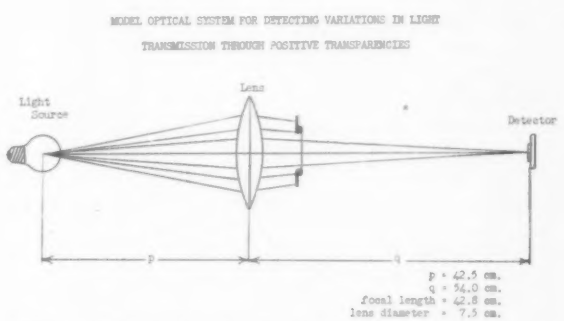

Fig. 4. Basic optics of transmission-determining instrument.

RESULTS AND DISCUSSION

Table 1 shows average ether extract values expressed as percent fat on a moisture-free basis, and percent light transmssion, for the three groups. The percent light-transmission values were found to have a high correlation with ether extract values.

Table 1. Data showing the means of the percent transmission and % fat (dry basis) for the three marbling classifications.

A		B		C	
% Transmission	% Fat (MFB)	% Transmission	% Fat (MFB)	% Transmission	% Fat (MFB)
5.11	11.86	12.13	22.35	20.34	37.64

Table 3. Data for three marbling classifications showing % fat (MFB), ether extract, % light transmission, subjective marbling score, and distribution index.

A				B				C			
Ether extract	% transmission	Subjective distribution score	Distribution index	Ether extract	% transmission	Subjective distribution score	Distribution index	Ether extract	% transmission	Subjective distribution score	Distribution index
11.75	8.18	5	2.72	23.69	11.88	5	3.62	43.72	19.80	3	13.05
15.03	6.75	3	3.42	25.33	14.40	3	7.50	41.53	18.36	4	7.26
15.03	3.70	6	2.42	23.15	12.84	3	6.50	24.84	18.18	5	9.24
14.75	5.38	3	.69	27.09	12.90	4	4.50	41.88	17.80	3	5.01
8.63	3.56	3	.55	22.40	11.58	5	4.26	39.29	18.60	3	6.94
10.49	5.43	4	3.15	23.27	10.42	5	5.41	38.40	18.65	3	4.73
10.55	3.53	3	.88	29.39	12.95	2	5.59	40.99	19.80	3	5.89
8.26	5.10	4	1.40	17.15	12.50	4	5.41	40.77	17.10	4	4.70
10.03	3.20	3	.61	12.48	11.80	5	4.57	37.81	34.34	4	8.07
14.07	6.20	3	8.56	19.52	10.00	4	3.35	27.18	20.96	4	4.76

The percent light-transmission data for the 30 samples were analyzed by analysis of variance, as shown in Table 2. The highly significant mean squares for the marbling groups indicate that the transmittance means of the three groups differ significantly from one another. With Duncan's multiple range test, it was demonstated that all means were significantly different at the .001 level.

When the marbling mean squares of the transmittance data were partitioned, into linear and quadratic components, the transmittance values appeared linearly related to marbling score over the range used in this study. Since only three levels were used, however, it is quite possible that a large range may have resulted in an increase of the quadratic term.

Since two marbling scores made up each group, the amount of variation within each group would have some significance in reflecting the sensitivity of the technique. Table 3 shows the percent light transmission, percent fat (MFB), subjective marbling score, and subjective distribution score for all samples. Standard deviations for light transmittance within each group were respectively 1.6, 1.2, and 5.0 for groups A, B, and C.

To determine the relations between marbling values as derived by this technique and those obtained subjectively, simple correlation coefficients were tabulated between percent fat (MFB) and subjective marbling score. The values obtained were +.83 between percent light transmitted and percent fat (MFB); +.93 between subjective marbling score and percent fat (MFB); +.88 between subjective marbling score and percent light transmittance.

The distribution index was calculated by determining the standard deviations of the nine scans obtained per sample. The lower standard deviation values indicate a more desirable or uniform distribution of marbling.

Correlation coefficients between subjective marbling distribution score and distribution index were low, suggesting that further modifications are necessary in this particular phase of the study. For example, the size of aperture used in scanning may be a factor affecting the sensitivity of the test.

Table 2. Analysis of variance on transmission data obtained from three marbling score groups.

Source of variation	df	Mean square
Marbling	2	581.635***
Linear	1	1163.270***
Quadratic	1	2.396
Error	27	9.396

*** p = .005

Correlations computed within each group showed that the relation between subjective marbling scores and percent transmission was low. So was the relation between ether extract and percent transmission.

If one uses percent ether-extractable fat or subjective marbling evaluation as controls, it must be concluded that the described technique is only able to detect large variations in marbling, and it is not sensitive enough to detect the smaller variations. However, it should be noted that in this study ether-extractable fat was determined on a ¼-in. slice and does not necessarily reflect an accurate estimate of surface visible fat, since nonvisible cellular fats would be included in the extractable fat value.

In the case of the subjective evaluation, one can also raise the question as to the repeatability of these estimates, particularly where detection of small differences is necessary.

ACKNOWLEDGMENT

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REFERENCES

A.O.A.C. 1950. "Official Methods of Analysis," 7th ed. Association of Official Agricultural Chemists, Washington, D. C.

Blumer, T. N., and H. P. Fleming. 1959. A method for the quantitative estimation of marbling in beef rib eye muscle. *J. Animal Sci.* **18**, 959.

Cover, S., O. D. Butler, and T. C. Cartwright. 1956. The relationship of fatness in yearling steers to juiciness and tenderness of broiled and braised steaks. *J. Animal Sci.* **15**, 464.

Orme, L. E., A. M. Pearson, L. J. Bratzler, and W. T. Magee. 1958. Specific gravity as an objective measure of marbling. *J. Animal Sci.* **17**, 693.

Schoonover, C. O., and P. O. Stratton. 1957. A photographic grid used to measure rib eye areas. *J. Animal Sci.* **16**, 957.

Wellington, G. H., and J. R. Stouffer. 1959. Beef marbling, its estimation and influence on tenderness and juiciness. *Cornell Univ. Agr. Expt. Sta.* Bull. 941.

Wang, H., E. Rasch, V. Bates, F. J. Beard, J. C. Pierce, and and O. G. Hankins. 1954. Histological observations on fat loci and distribution in cooked beef. *Food Research* **19**, 314.

Palmer, A. Z., J. W. Carpenter, R. L. Alsmeyer, H. L. Champman, and W. G. Kirk. 1959. Simple correlations between carcass grade, marbling, ether extract of loin eye and beef tenderness. *J. Animal Sci.* **17**, 1153.

Lewis, Bernadine L., Dorothy L. Harrison, and Dean S. Folse. 1958. A photomicrographic method of estimating the quality and distribution of fat in muscle tissue. *Food Research* **23**, 1.

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Factors Affecting the Corrosiveness of Concentrated Tomato Products

(Manuscript received May 26, 1961)

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SUMMARY

Investigation was made of some of the causes for the corrosiveness of tomato paste, besides copper contamination and the products of caramelization (already evaluated). Degradation products of ascorbic acid and demethoxylated pectin were found to accelerate container corrosion when added to tomato paste. Several currently accepted packing practices tend to increase the concentrations of these compounds, resulting in a parallel increase in corrosiveness. Three major preparation and packing factors were shown to lead to a shortened service life of canned concentrated tomato products: 1) aeration of the product during manufacture; 2) failure to inactivate the enzymes quickly enough; 3) slow cooling. Of these three, the last had the greatest effect in increasing corrosion.

PREVIOUS RESEARCH has shown that heat damage occurring during processing and storage increases the corrosiveness of concentrated tomato products. This effect becomes more pronounced as the concentration increases. It was further noted that heat damage as a cause of early corrosion losses in canned tomato products can be evaluated by spectrophotometric examination of the serum (Hernandez and Feaster, 1960; Luh *et al.*, 1958). However, commercial samples of inadequately cooled cans of tomato paste have often had a shorter storage life than would be anticipated by examination of the optical density of the serum. The present study was conducted to gain further insight into the fundamental causes of early corrosion failures in tomato paste in plain tinplate cans.

The corrosive effects of copper in tomato paste have long been recognized. Paste packers know that copper derived from oxidized brass or bronze equipment can shorten the life of the canned product. In recent commercial corrosion losses, however, no significant amount of copper could be found in the failed cans, so other factors affecting the corrosiveness of the product were sought.

The factors that lead to oxidative breakdown of ascorbic acid have been known for many years. Previous work has centered on the loss of nutritional value (N.C.A., 1955). Several years ago, Willey and co-workers (Willey, 1959) showed that dehydroascorbic acid and diketogulonic acid at 10–100 mg/100 g added to fruit juice or citrate buffer at pH 4.0 would attack tin with vigor. Tomato juice normally contains about 20 mg of ascorbic acid per 100 g of juice. A concentration of 100 mg/100 g might be expected in paste after a fivefold concentration. If as little as 10% of the ascorbic acid is converted to dehydroascorbic acid during paste manufacture, this could be a factor in producing more corrosive paste.

The role of pectin and its breakdown products has been extensively investigated with regard to product quality and consistency (Kertesz and Laconti, 1944; McColloch and Kertesz, 1949). The effect of these substances on corrosiveness has not been reported. However, the effect of high-methoxy pectin, low-methoxy pectin, and galacturonic acid on the corrosiveness of pear nectar toward coupled and uncoupled tin and iron has been examined (Willey *et al.*, 1953). Low-methoxy pectin (LMP) was shown to accelerate the corrosion of coupled tin. As little as 0.2% added low-methoxy pectin reduces the service life of normal pear nectar in plain-bodied cans to 6 months.

It thus seemed advisable (1) to study the effects of the degradation products of ascorbic acid and pectin on the service life of canned tomato paste; and (2) to make some preliminary observations of handling procedures of tomato paste packers that would result in formation of these degradation products.

EXPERIMENTAL

Ascorbic acid. *Analysis of commercial samples.* Samples of commercial tomato paste packed in 603 × 700 plain-bodied common coke cans were analyzed immediately after packing and after 3, 6, and 12 months' storage for the presence of ascorbic, dehydroascorbic, and diketogulonic acids, using the 2,4-dinitro-phenylhydrazine method (A.V.C., 1951). For analysis, one sample was taken from the center and one from the edge of each container.

Addition of dehydroascorbic acid. The effect of direct addition of dehydroascorbic acid to tomato paste was also studied. Thirty 603 × 700 plain-bodied common coke cans containing tomato paste at 195–200°F were removed after the filler on a commercial line. Ten ml of distilled water were added to each of 10 cans to serve as controls. Ten ml of water containing 300 mg of dehydroascorbic acid were added to each of 10 additional cans, and 10 ml of water containing 750 mg of dehydroascorbic acid were added to each of the remaining 10 cans. The contents of each can were then stirred 10 sec, and the can was closed and given a 3-min cook in boiling water. The cans were then air-cooled on trays. All test cans were stored one year at room temperature in the laboratory, and then emptied, and the extent of corrosion on the bodies was graded visually.

Effect of aeration. Two small steam-jacketed kettles were filled with 26% paste from the final concentration stage. The paste in one of the kettles was maintained at 190–200°F and had a steam atmosphere over its surface. The other kettle was also maintained at this temperature but was stirred (aerated) 10 min with a Lightnin' mixer. The paste was then filled by hand into plain-bodied common coke 603 × 700 cans. The cans were closed, and air-cooled on trays.

Any subsequent corrosion was determined by measuring actual tin loss on the can wall. The initial coating weight was measured on the inside of the unformed body blanks by use of an X-ray tin-coating weight gauge. At scheduled intervals after the pack was made, the tin remaining on the container wall was determined by electrolytically stripping (Kunze and Willey, 1952) a 4-sq-in. disc punched from the area on which the original tin coating weight was known.

Table 1. Details of cooling procedures.[a]

Cannery code	Pack No.	Solids of paste	Cooling procedure	Temperature (°F) range after: 1 hr Center	1 hr Edge	3 hr Center	3 hr Edge	24 hr Center	24 hr Edge
A	3 & 4	32%	#1) 2-hr-10-min in a Gunderson-Zimmerman evaporative cooler	180–184	122–146	100–130	84–118	72–80	73–79
			#2) 30-min immersion in 70°F tap water	162–168	110–122	120–128	110–122	76–81	78–81
			#3) air-cooled	188–190	170–182	160–168	145–160	88–108	90–106
B	2	26%	#1) 2-hr-10-min immersion in 63°F tap water	152–152	107–109	86–87	80–82	74–78	77–81
			#2) 20-min immersion in 63°F tap water	150–162	120–130	114–120	110–118	84–90	85–92
			#3) air-cooled	180–184	165–177	154–164	154–158	104–115	103–116
C	1	30%	#1) 20-min air-cool followed by 2-hr-10-min immersion in 64°F tap water.	152–160	104–118	93–94	86–92	68–74	68–72
			#2) 20-min air cool followed by 30-min immersion in 64°F tap water	145–166	119–129	120–120	116–118	72–84	72–82
			#3) air-cooled	185–193	172–181	170–172	158–162	90–92	87–88

[a] Four or more cans for each variable.

Ascorbic, dehydroascorbic, and diketogulonic acids in samples of the paste were determined immediately after packing, by the 2,4-dinitro-phenylhydrazine method.

Pectins. *Analysis of commercial samples.* The pectic substances in commercial tomato paste were determined. Protopectic acid (PP), high-methoxy pectin (HMP), and low-methoxy pectin (LMP) were fractionated by the method of Dietz and Rouse (1953). The galacturonic acid and lower polygalacturonides were analyzed by the procedure suggested by R. M. McCready (1960): Twenty-five grams of tomato product were diluted to 2½% solids. (Refractive indices were used to obtain the original concentration of solids.) An aliquot of 40 ml was mixed with 5 g of Dowex-50 (analytical grade, hydrogen form). The slurry was poured on a 5-g column of Dowex-50 (hydrogen form). A 30-ml aliquot of the effluent was then chromatographed on a 5-g column of Dowex-1 (analytical grade, acetate form) that had been previously washed with 1 L of distilled water. The Dowex-1 column containing the galacturonic acid fraction was washed with 1 L of distilled water, and the galacturonic acid and low-molecular-weight polygalacturonides were next eluted with 200 ml of 0.15 molar acetic acid. The carbazole reaction described by Dietz and Rouse was used to determine the galacturonic acid colorimetrically.

Added pectin. To demonstrate the effect of the products of pectic acid breakdown on the corrosiveness of tomato paste, low-methoxy pectin was added to 603 × 700 plain-bodied cans of paste at the rate of 200 and 500 mg/100 g. Galacturonic acid in the amount of 500 mg/100 g was added to other cans. The sealed cans were air-cooled and then stored 3 months at 70°F. The corrosiveness of the product was judged by visually grading the detinning of the can bodies.

Enzymatic inactivation and cooling. Experimental packs were made in three different canneries to analyze the effect of variations in extraction procedures, and of the rapidity of cooling, on the corrosiveness of tomato paste. Two packs were prepared with a "hot break" pulp, and two packs with "cold break" pulp. For the purposes of this work, "hot break" was defined as bringing the pulp to a minimum of 185°F in less than 20 sec after crushing the tomato (McColloch *et al.*, 1950). In each of the test packs, enzyme inactivation was by tubular heater. In packs No. 2 and No. 3, 185°F was attained in less than 20 seconds, resulting in a "hot break" paste. In pack No. 1, a tomato seed extractor was used before heating to 185°F, resulting in "cold break" conditions. In pack No. 4, the heater was operated at 160–165°F, also resulting in "cold break" conditions. One-third of the cans in each pack were thoroughly water-cooled, one-third were air-cooled, and one-third were given a partial water-cool followed by bright-stack air-cooling. Details of the cooling procedures are given in Table 1.

Bodies of all of the cans were fabricated from plate on which the tin-coating weight had been determined by an X-ray tin-coating weight gauge. Four cans of each cooling variable were opened for examination 1, 7, 30, 90, and 180 days after packing. At each of these examinations the weight of tin coating remaining was determined by the method of Kunze and Willey (1952) on 4-sq-in. discs cut from these cans.

Paste taken from the initial and 180-day samples was analyzed for ascorbic acid fractions, pectic acid fractions, and optical density of the serum.

RESULTS

Ascorbic acid. *Analysis of commercial samples.* Table 2 shows analytical results for a group of commercial samples of paste, illustrating the stability of ascorbic, dehydroascorbic, and diketogulonic acids in plain-bodied cans. All lots of paste were quite corrosive, and it will be noted that they were found to contain approximately the range of dehydroascorbic and diketogulonic acids suspected to contribute to corrosiveness. It is of interest to note, where available, information on the increase in ascorbic acid and the corresponding decrease in dehydroascorbic acid during initial storage. This change is probably at the expense of tin on the container.

Addition of dehydroascorbic acid. Table 3 shows the results of direct addition of dehydroascorbic acid to tomato paste. The effect of this oxidizing agent on detinning of plain-bodied cans is clearly demonstrated.

Table 2. Stability of ascorbic, dehydroascorbic, and diketogulonic acids in the plain-bodied 603 × 700 can of tomato paste.[a]

Paste sample	Year	Solids	Ascorbic acid (mg/100 g) After months: 0	3	6	12	Dehydroascorbic acid (mg/100 g) After months: 0	3	6	12	Diketogulonic acid (mg/100 g) After months: 0	3	6	12
B	1958	26	....	35	32	12 [b]	....	6	6	0 [b]	..	4	5	2 [b]
B	1959	26	78	88	84	....	12	5	6	..	8	5	5	..
K	1959	46	90	95	75 [b]	....	8	2	4 [b]	..	8	6	3 [b]	..

[a] All values represent duplicate analyses: one sample taken adjacent to the wall of the container, and one taken from the center of the can.
[b] Can totally detinned.

Table 3. Effect of direct addition of dehydroascorbic acid to 26% tomato paste (ten 603 × 700 cans per variable examined after 1 year at room temperature).

Dehydroascorbic acid added (mg/100 g)	Detinning grade [a]	Vac. (Hg in.)
0	4	12
10	6	9
25	10	10 [b]

[a] Square root of percent base steel or alloy exposed.
[b] All cans of this lot swelled after 15 months.

Effect of aeration. Fig. 1 shows the effect of whipping air into the hot product. Ascorbic acid analyses of each of the variables are given. Filled can weights and can vacuum measurements were not significantly different in the two lots of paste. It is recognized that factors other than the oxidation of ascorbic acid may be involved, but the effect of aerating the paste on the detinning rate is striking.

Pectins. *Analysis of commercial samples.* Table 4 shows the results of analysis of commercial samples of paste for pectic substances. The samples are listed in this table in the order of increasing corrosiveness. On this basis, the water-cooled samples come first. Within this rapidly cooled series of samples there is also a parallel between increasing LMP and galacturonic acid combined values and increasing corrosiveness. A similar relationship is present within the air-cooled lots. Although water-cooled, the final sample in the table was an exception and was very corrosive. However, this material was undoubtedly heat-damaged during concentration since the optical density of the serum was 0.38 at 420 mμ.

Addition of low-methoxy pectin. Table 5 shows the effect of the direct addition of LMP and galacturonic acid to 26% tomato paste packed in plain-bodied cans and stored 3 months at 70°F. The corrosive nature of either added LMP or galacturonic acid can be observed even at levels as low as 0.2% added LMP.

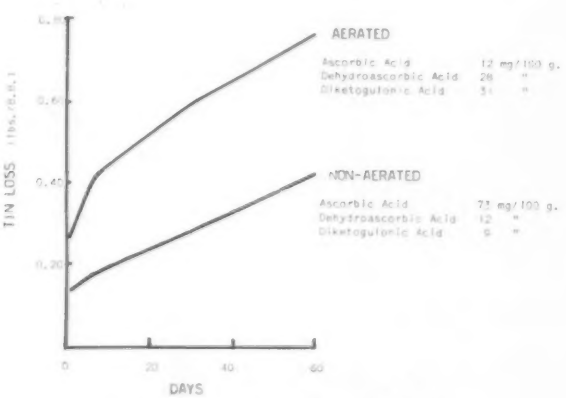

Fig. 1. Effect of aeration on detinning.

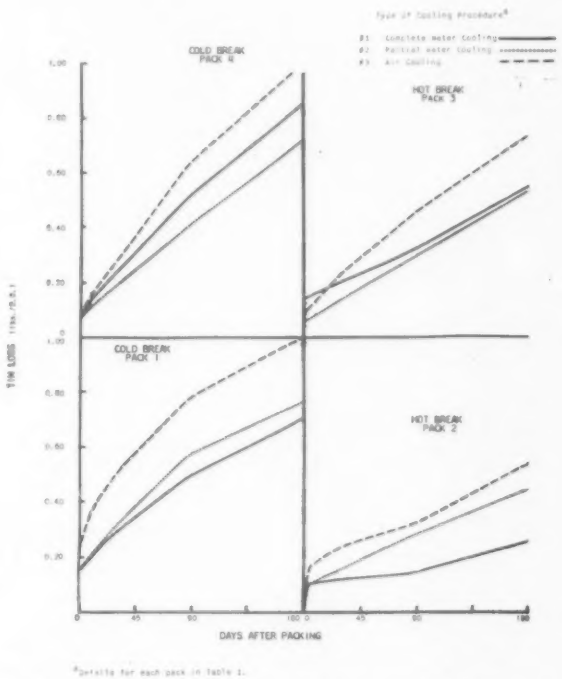

Fig. 2. Effect of enzyme inactivation and cooling on detinning.

Enzyme inactivation treatment and cooling method. Basic chemical analyses of the paste used in these experiments are presented in Tables 6 and 7. No significant heat damage was observed in any of the paste except that used in Pack No. 1. This heat damage is also reflected in a slight loss of ascorbic acid in this paste. Except for differences in pectins, the other 3 packs are comparable in the factors measured. The effect of type of break, however, is clearly demonstrated in the pectin analysis of these packs.

The corrosiveness of the paste is illustrated by Fig. 2, which plots the average rate of tin loss from 4 cans of each variable. After an initial detinning, which is largely determined by the cooling procedures, relatively constant detinning is established. This rate is affected primarily by the type of "break," and also to some degree by the cooling procedure. The differences in benefits from cooling procedure 1 in packs 3 and 4 as com-

Table 4. Pectic fractions of commercial tomato products samples, arranged in order of increasing corrosiveness.

Packer and year	No. samples	% solids	Pectic fractions: OD (420 mμ)	PP (mg/100 g)	HMP (mg/100 g)	LMP (mg/100 g)	LMP plus galacturonic acid (mg/100 g)	Cooling
D-59	8	30	0.00	276	540	24	24	Water
I-58	4	26	0.00	42	177	83	187	Water
I-59	4	33	0.00	92	356	158	158	Water
I-58	4	32	0.02	64	320	154	538	Water
A-58	4	32	0.03	26	179	64	512	Water
L-59	4	30	0.10	36	132	24	96	Air
F-59	8	14	0.00	22	90	22	56	Air
H-59	8	10	0.00	20	24	20	44	Air
B-58	10	26	0.01	0	740	312	385	Air
B-59	4	26	0.02	0	437	177	291	Air
M-59	8	17	0.04	7	476	326	361	Air
C-59	10	30	0.00	0	540	324	492	Air
K-59	4	46	0.38 [a]	0	1040	570	810	Water

[a] An optical density of this magnitude indicates heat damage.

Table 5. Effect of direct addition of low-methoxy pectin and galacturonic acid to 26% tomato paste (all cans examined after 3 months' storage at room temperature).

No. of 603 × 700 cans	Compound added	Amount added (mg/100 g)	Av. detinning grade [a]
6	None	None	1
3	Low-methoxy pectin	200	2
6	Low-methoxy pectin	500	7
6	Galacturonic acid	500	5

[a] The square root of the percent of base steel or alloy exposed.

pared to packs 1 and 2 are due to the fact that we assumed (wrongly) that a 2-hr-10-min Gunderson-Zimmerman cooling would be equivalent to a 2-hr-10-min water-immersion cooling. It is out of the scope of this paper to evaluate different cooling techniques, so we have treated the paste cooled in the Gunderson-Zimmerman cooler as water-cooled.

The effect of the "break" on the corrosiveness of the paste is further illustrated in Fig. 3, which combines the 6 variables of each break classification shown in Fig. 2. The effect of the cooling procedures is illustrated in Figure 4, where the data for each of the 4 packs are averaged by type of cooling used. As shown by the optical-density data in this chart, heat damage as such was not severe enough to affect the corrosiveness of the paste materially.

DISCUSSION

Ascorbic acid. Any evaluation of the role of ascorbic acid in corrosion must take into account the fact that tomato paste represents a complex organic system. In such a system, it is difficult to evaluate the effect of the oxidation of a single compound. The effect observed may not have been caused solely by the compound under study. Oxidative changes in other compounds could be responsible or at least contributory. It is even harder to determine the effect of any compound after the food has been stored in a can for a period of months, since stored food is chemically a relatively dynamic system.

The oxidation-reduction system represented by ascorbate, dehydroascorbate, and diketogulonate is intimately tied to product and container interactions. The analyses of the ascorbic acid fractions show, in the levels of ascorbic, dehydroascorbic, and diketogulonic acids, fluctuations that are a function not only of initial level but also of storage time and the progress of container corrosion. Storage temperature is another factor that influences these values. However, the data presented here show that oxidative changes in tomato products markedly affect the corrosiveness of the canned material in addition to causing nutritional losses. In the aeration experiment, it should be noted that the corrosiveness of both experimental lots of paste was higher than that of the commercial product being canned directly from the filler bowl. This emphasizes the importance of rapid handling of the concentrated product.

Pectic substances. Evaluation of the results of the pectic experiment presents the same type of problems as those discussed above. Further, unless the initial "break" temperatures have been high enough to destroy all tomato enzymes, numerous reactions will occur in the pulp during the concentration. These reactions will continue until a temperature is reached that destroys all enzymes. It is impossible to predict what the predominant reactions are under the wide variety of conditions existing in commercial break procedures that are inadequate to inactivate all enzymes.

Data have been presented to show that the procedures used for inactivating enzymes can markedly influence the corrosiveness of tomato concentrates. The

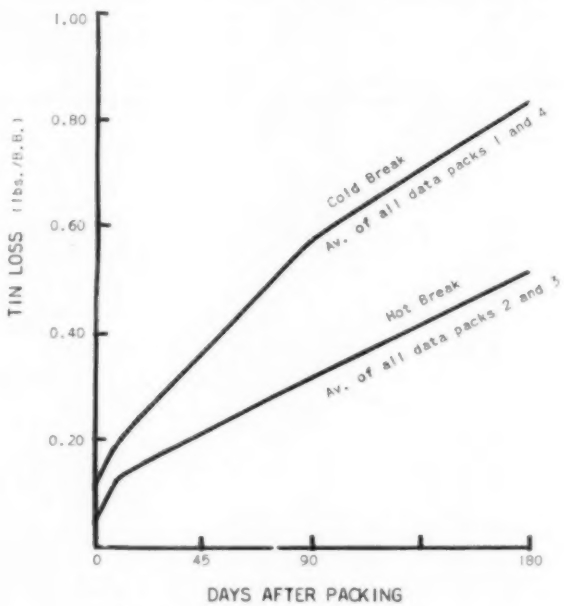

Fig. 3. Effect of break on detinning.

Table 6. Effect of enzyme inactivation and cooling on ascorbic acid content.

Pack No.	Break	Solids (%)	Cooling procedure	Optical Density (420 mμ)	Ascorbic acid (mg/100 g) Initial	Ascorbic acid (mg/100 g) 6 mo	Dehydroascorbic acid (mg/100 g) Initial	Dehydroascorbic acid (mg/100 g) 6 mo	Diketogulonic acid (mg/100 g) Initial	Diketogulonic acid (mg/100 g) 6 mo
1	Cold	26	1	0.10	25	20	9	2	2	1
			2	0.11	25	19	9	2	3	1
			3	0.15	19	17	10	2	6	2
2	Hot	30	1	0.00	40	30	6	9	0	0
			2	0.00	39	31	7	10	0	0
			3	0.02	36	25	8	11	1	0
3	Hot	32	1	0.00	39	39	8	3	4	3
			2	0.00	43	39	6	2	3	3
			3	0.03	40	35	9	3	4	3
4	Cold	32	1	0.00	48	39	2	2	2	6
			2	0.00	49	42	7	2	2	2
			3	0.07	47	37	11	2	2	5

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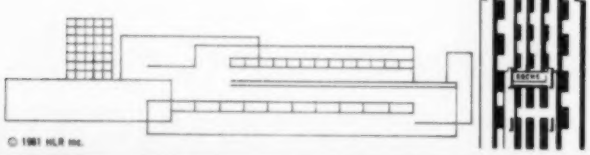

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Table 7. Effect of enzyme inactivation and cooling on pectic content.

Pack No.	Break	Cooling procedure	Protopectin (mg/100 g)		High-methoxy pectin (mg/100 g)		Low-methoxy pectin (mg/100 g)		Galacturonic acid plus LMP (mg/100 g)	
			Initial	6 mo	Initial	6 mo	Initial	6 mo	Initial	6 mo
1	Cold	1	72	60	216	144	432	360	468	418
		2		60		144		360		396
		3		48		132		384		456
2	Hot	1	114	73	395	312	208	208	208	239
		2		83		312		208		239
		3		83		302		218		250
3	Hot	1	39	39	422	281	77	77	205	205
		2		39		371		90		218
		3		39		371		77		205
4	Cold	1	26	26	333	281	205	128	397	371
		3		26		281		115		384
		3		26		281		128		371

addition of LMP or galacturonic acid to tomato paste has also been shown to accelerate detinning. However, it would be an improper inference to ascribe all of the results reported here to these compounds alone. Other compounds may also be involved in enzymatic degradation and form substances that inhibit or accelerate corrosion. Nevertheless, the pectin breakdown reactions reported here parallel the formation of a more corrosive paste. For example, a change in "break" procedure at Cannery A produced both a higher level of LMP and galacturonic acid, and a markedly shorter service life for the canned paste.

It is recognized that, for a variety of reasons, "hot breaks" as here defined (185°F in less than 20 sec) are not being achieved by most canners. In some cases the canner does not wish to produce a high-consistency paste, because of added handling difficulties in the plant or because of the desires of his trade. On the other hand, some packers who aim for those conditions do not attain them. This arises from lack of compensation for temperature come-up delays in tubular heaters and delays incurred in sumps and excess piping. All of these factors can be eliminated by suitable equipment and by layout changes.

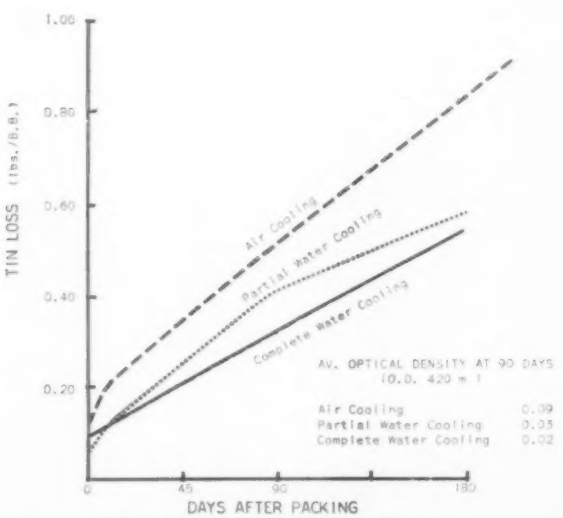

Fig. 4. Effect of cooling on detinning.

Cooling. The importance of adequate cooling of tomato products has been emphasized (Hernandez and Feaster, 1960). As shown by the analyses of the commercial samples for pectin factors, more rapid cooling of canned paste appears to minimize corrosive pectic fractions in the product. This was demonstrated in the experiments designed to study the combined effect of enzyme inactivation and of cooling. The initial detinning, which took place within one day of packing, was considerably higher for air-cooled paste. Furthermore, the rate of detinning after the cans reached the storage temperature was also greater for the slowly cooled samples than for those cooled more rapidly. This led to an over-all detinning rate for air-cooled paste that was approximately 50% higher than for water-cooled paste.

Good cooling acts in at least two ways to retard detinning. It quickly lowers the temperature of the product in contact with the can wall, even though the average product temperature may still be quite high. This prevents an initial rapid detinning and leaves more tin available for shelf-life protection. Secondly, product breakdown caused by heat is minimized.

The air-cooling conditions used were more rapid than those encountered commercially, where large blocks of cans are handled. Can center temperatures as high as 145°F have been encountered commercially after 3 days of bright-can stacking. It can be assumed that the service life of paste subjected to these less favorable cooling procedures will show a correspondingly greater loss of shelf life. It is of interest to note that none of the instances of commercial losses in tomato paste encountered during all of the work on this corrosion problem occurred in water-cooled packs.

Since efficient cooling results in improved shelf life, and provides better color and flavor retention and improved nutritional value, it would seem that better cooling procedures should receive due consideration by canners.

ACKNOWLEDGMENT

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REFERENCES

A.V.C. 1951. Methods of Vitamin Assay, 2nd ed. The Association of Vitamin Chemists. Interscience Publishers, London, England. p. 93.

Dietz, J. H., and A. H. Rouse. 1953. A rapid method for estimating pectic substances in citrus juices. *Food Research* **18**, 169.

Hernandez, H. H., and J. F. Feaster. 1960. Optical density of tomato serum from concentrates as a measure of heat induced changes in product corrosivity. *Food Technol.* **14**, 468.

Kertesz, Z. I., and J. D. Laconti. 1944. Factors determining the consistency of commercial canned tomato juice. N.Y. State Agr. Expt. Sta. Bull. 272.

Kunze, C. T., and A. R. Willey. 1952. Electrolytic determination of tin and tin-iron alloy coating weights on tin plate. *J. Electrochem. Soc.* **99**, 354.

Luh, B. S., S. Leonard, and G. L. Marsh. 1958. Objective criteria for storage changes in tomato paste. *Food Technol.* **12**, 347.

McColloch, R. J., and Z. I. Kertesz. 1949. Recent developments of practical significance in the field of pectic enzymes. *Food Technol.* **3**, 94.

McColloch, R. J., B. W. Nielson, and E. A. Beavens. 1950. Factors influencing the quality of tomato paste. *Food Technol.* **4**, 339.

McCready, R. M. 1960. Private communication.

N.C.A. 1955. Retention of Nutrients During Canning. National Canners Assoc. p. 44.

Willey, A. R. 1959. Private communication.

Willey, A. R., D. C. Vosti, and J. C. Connell. 1953. Unpublished report.

The Use of Antioxidants in Canning Apple Halves*

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SUMMARY

When apple halves were canned without oxygen removal the headspace of the can contained 10–12 volume percent oxygen. The addition of ascorbic acid at 300 mg per lb of fruit controlled browning, reduced headspace oxygen, protected the container from corrosion and increased the residual ascorbic acid content.

UNLIKE MOST FRUITS, apples are usually canned without added sugar and are not ready for immediate dessert use. Apple sectors and rings have been canned in syrup experimentally (McCornack *et al.*, 1940), but no process has been suggested for apple halves.

When apples are canned it is essential to remove oxygen from the tissues to prevent subsequent corrosion and "pinholing" of the metal container (Kohman and Sanborn, 1928; Lueck and Blair, 1928). In commercial practice this is accomplished by physical means (vacuum, heat) or by respiration in the absence of air (brine soak) (Crawford, 1927; Culpepper and Moon, 1929; Grab, 1925; Hansen, 1927; Sellers, 1918). These methods are inapplicable to the canning of apple halves, because of the thickness of the tissue pieces. The removal of oxygen by chemical methods has received little attention.

Antioxidants have been used in the freezing preservation of apples (Sellers, 1918) and in the manufacture of apple juice (Tressler and Joslyn, 1954). Sulfur dioxide may hasten can corrosion (Cruess, 1948), and imparts an off-flavor to the product. Ascorbic acid, on the other hand, imparts no detectable flavor and is not known to affect metal containers. It has the added advantage of being a desirable dietary supplement. Isoascorbic acid and glucose–ascorbic acid have been found to inhibit oxidative discoloration in raw fruit (Bauerenfeind and Siemers, 1945) but do not have the antiscorbutic properties of ascorbic acid. An enzyme mixture (glucose oxidase–catalase) has been used to reduce the oxygen content of canned soft drinks and beer (Barton *et al.*, 1957).

These compounds are all more or less heat-labile and probably would be impaired during the canning process, although Zilva *et al.* (1935) found only partial destruction of added ascorbic acid during canning. During retort "come-up," however, temperatures may be conducive to a reaction between an antioxidant and the oxygen in the product. The exploitation of this possibility was the aim of this investigation.

The work falls naturally into two phases—determination of the amount of oxygen present and the efficacy of various compounds in removing the oxygen.

MATERIALS AND METHODS

The amount of oxygen in apple flesh was estimated by removing the air from the tissues under vacuum and analyzing a sample for oxygen content. Air was removed and collected by the apparatus shown in Fig. 1. Peeled and cored apples were segmented longitudinally to give wedges approximately ⅜ in. on the edge. Lots of 200 ml, measured by water displacement, were placed in flask A. By manipulation flask A, column B, and pipette D were completely filled with deaerated water. Stopcock C was then closed and a vacuum drawn on column E.

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Water from B was drawn into E, creating a vacuum in B. Air arising from the apple tissue collected in the top of column B. After closing stopcock F and opening C, the gas was drawn into pipette D by reduced pressure. The volume was noted. Carbon dioxide was removed by rinsing with a solution of potassium hydroxide, and the oxygen fraction was determined by absorption with alkaline pyrogallol solution.

Preliminary trials showed little increase in gas volume after 15 min of extraction. Therefore, an extraction time of 20 min was used throughout the test series.

The fruit was selected at random from storage. Twenty-five separate extractions were made for each variety. The varieties used for gas volume determinations included Red Delicious and Golden Russet from 40°F storage, and Red Delicious, McIntosh, and Cortland from 32°F storage.

In the second phase of the experiment, apples of the varieties Cortland, Red Delicious, and McIntosh were canned by the following procedure. Fruits from 32°F storage were peeled and cored on mechanical peelers, halved, and submerged in 1% sodium chloride brine for 5 min. The antioxidants, in quantity just sufficient to combine with the oxygen present in the apple tissue, were weighed into empty 20-oz plain tin cans. The fruit halves were rinsed in cold water, packed in the cans, covered with 25% sucrose syrup at 200°F, and sealed immediately. The sealed containers were processed 10 min at 212°F and cooled in water.

The treatments replicated six times were ascorbic acid, isoascorbic acid, sodium isoascorbate, glucose oxidase-catalase, and an untreated check.

After 2 months, 2-cc samples of gas were drawn from the headspace of the can with a modified Camden manometer (Kefford and Davis, 1954) and analyzed for oxygen content by the micromethod of Fry (1949). The contents of the cans were examined organoleptically, and samples of syrup and fruit were taken for ascorbic acid analysis.

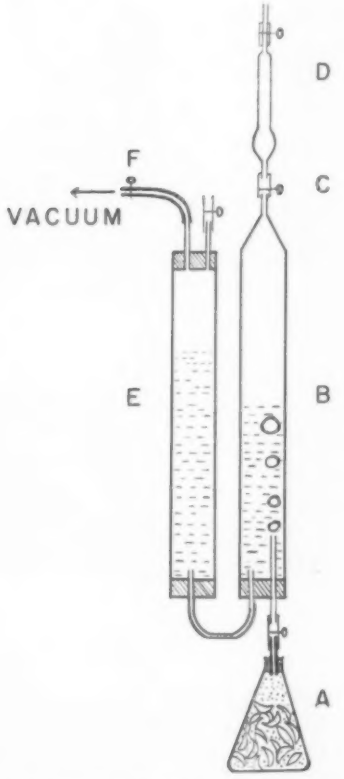


Fig. 1. Apparatus for removing gases from apple tissue.

The experiment was repeated with ascorbic acid at an increased rate of 300 mg per pound of fruit and equivalent weights of isoascorbic acid and sodium isoascorbate. Glucose oxidase–catalase was not included in this series. The canned fruit was stored 6 months at room temperature before examination.

RESULTS AND DISCUSSION

The volume of gas extracted varied from 20 to 30% of the tissue volume with different varieties (Table 1). This is in agreement with the 12–29% reported by Bitting (1937) and Magness (1920). There was no difference between the two Red Delicious lots stored at 32 and 40°F.

Table 1. Percent of total gas and oxygen by volume in the flesh of apples stored at 32 and 40°F.

Variety	(°F)	Gas in tissue	Oxygen in gas	Oxygen in tissue
Golden Russet	(40°)	21.4 ± 1.34	11.6 ± 1.36	2.48
Red Delicious	(40°)	23.7 ± 1.83	13.3 ± 1.97	3.03
Red Delicious	(32°)	22.3 ± 1.58	18.7 ± .57	4.17
McIntosh	(32°)	28.5 ± 1.08	13.4 ± 1.77	3.80
Cortland	(32°)	30.6 ± 2.89	15.8 ± 2.85	4.84

The percent of oxygen in the extracted gas was higher in some varieties than in others. The proportion of oxygen was greater in the Red Delicious stored at the lower temperature than at the higher. This is also in agreement with Magness (1920).

From these data the percent oxygen in the apple tissue was calculated. It was found to range from 2.48% by volume in Golden Russet to 4.84% in Cortland.

When chemically equivalent amounts of antioxidants were mixed with apple halves prior to retorting there was, in most cases, a reduction in the oxygen content of the headspace (Table 2). The chief exceptions were samples treated with glucose oxidase–catalase, in which there was an increase in oxygen. Differences between ascorbic acid, isoascorbic acid, and sodium isoascorbate, if present, were obscured by the variation within treatments. None of the treatments reduced the oxygen content below 5%. None of the treatments had any detectable residual ascorbic acid.

Appearance of the fruit canned without treatment or with glucose oxidase–catalase was completely unsatisfactory because of excessive browning. Sodium isoascorbate and isoascorbic acid both gave some protection in that discoloration was confined to the core area. In Red Delicious this discoloration was an unsightly brown, whereas in McIntosh it was an unattractive pink that gradually spread to the sur-

Table 2. Oxygen in headspace of canned apples treated stoichiometrically with antioxidants.

Variety	Oxygen content (vol. percent)				
	Ascorbic acid	Iso-ascorbic acid	Sodium iso-ascorbate	Glucose oxidase-catalase	No treatment
Red Delicious	6.5	7.3	9.1	12.9	10.9
McIntosh	5.6	11.3	11.6	17.8	11.5
Cortland	6.2	10.2	11.1	18.7	11.7

Difference required for significance ($p = .05$), 4.3 (Snedecor, 1957).

rounding cortex after the cans were opened. In Cortland the discoloration was confined to a very slight browning of the core area.

Fruit packed with ascorbic acid showed less discoloration than fruit receiving other treatments. Discoloration in McIntosh was confined to the core area. Cortland was an over-all light, slightly golden color, with practically no discoloration.

Flavor was flat and insipid in the sodium isoascorbate and isoascorbic acid packs, and unpleasantly "off" in the glucose oxidase–catalase and untreated check. The ascorbic acid packs were all of acceptable flavor, Cortland having an excellent apple flavor characteristic of the variety.

Apple halves canned with increased rates of antioxidant (equivalent to ascorbic acid at 300 mg per pound) showed no discoloration and were of excellent flavor. The gray-green color natural to Red Delicious flesh was not acceptable to a taste panel, but the bright appearance of Cortland was very attractive. McIntosh halves were of good appearance and flavor but were undesirably soft.

In the cans of treated fruit stored at room temperature for six months there was no noticeable change in appearance and there was no detectable corrosion of the containers. Fruit of the untreated checks became dark brown, and the cans showed considerable etching of the sides and end. Fruit treated with ascorbic acid at 300 mg per pound had a residual ascorbic acid content of 18–24 mg/100 g (Table 3). Headspace oxygen was reduced to 0.3–0.6%. Isoascorbic acid and sodium isoascorbate were less effective.

Table 3. Headspace oxygen and ascorbic acid content of apples canned with antioxidants at a rate equivalent to 300 mg ascorbic acid per pound.

	Cortland		McIntosh		Delicious	
Antioxidant	Oxygen in headspace (vol. %)	Ascorbic acid (mg/100 g)	Oxygen in headspace (vol. %)	Ascorbic acid (mg/100 g)	Oxygen in headspace (vol. %)	Ascorbic acid (mg/100 g)
Ascorbic acid	0.33	23.48	0.40	18.83	0.63	24.55
Isoascorbic acid	2.60	8.26	2.88	3.61	1.86	9.12
Sodium isoascorbate	2.61	7.50	2.73	4.34	2.12	8.76
Check (no treatment)	12.05	1.75	10.84	0.75	11.34	2.75

REFERENCES

Barton, R. R., S. S. Rennert, and L. A. Underkopfler. 1957. Glucose oxidase catalase in the protection of foods and beverages. *Food Technol.* **11**, 683.

Bauerenfeind, J. C., and G. F. Siemers. 1945. Adding ascorbic acid to peaches before freezing. *Food Inds.* **17**(7), 79.

Bitting, A. W. 1937. Appertizing: the art of canning. Trade Press Room, San Francisco.

Crawford, S. L. 1927. U. S. Patent No. 1,631,017, May 31.

Cruess, W. V. 1948. "Commercial Fruit and Vegetable Products." p. 279. McGraw-Hill Book Co.

Culpepper, C. W., and H. H. Moon. 1929. Specific gravity determination as a guide in selection of suitable material for canning and for control of exhaust. *Canner* **68**(8), 21.

Fry, F. E. J. 1949. A simple gas analyzer. *Can. J. Research* E **27**, 188.

Grab, E. G. 1925. U. S. Patent No. 1,557,358, October 13.

Hansen, O. H. 1927. U. S. Patent No. 1,625,207, April 19.

Kefford, J. F., and E. G. Davis. 1954. Headspace gas composition. *Food Preserv. Quart.* **14**, 46–59.

Kohman, E. F., and N. H. Sanbord. 1928. Tin plate and the electrochemical series. *Ind. Eng. Chem.* **20**, 76.

Lueck, R. H., and H. T. Blair. 1928. Corrosion in the tin can. *Trans. Am. Electrochem. Soc.* **54**, 257.

McCornack, A. A., C. R. Fellers, and W. A. Maclinn. 1940. Canned dessert apples. *Fruit Prod. J.* **20**, 5.

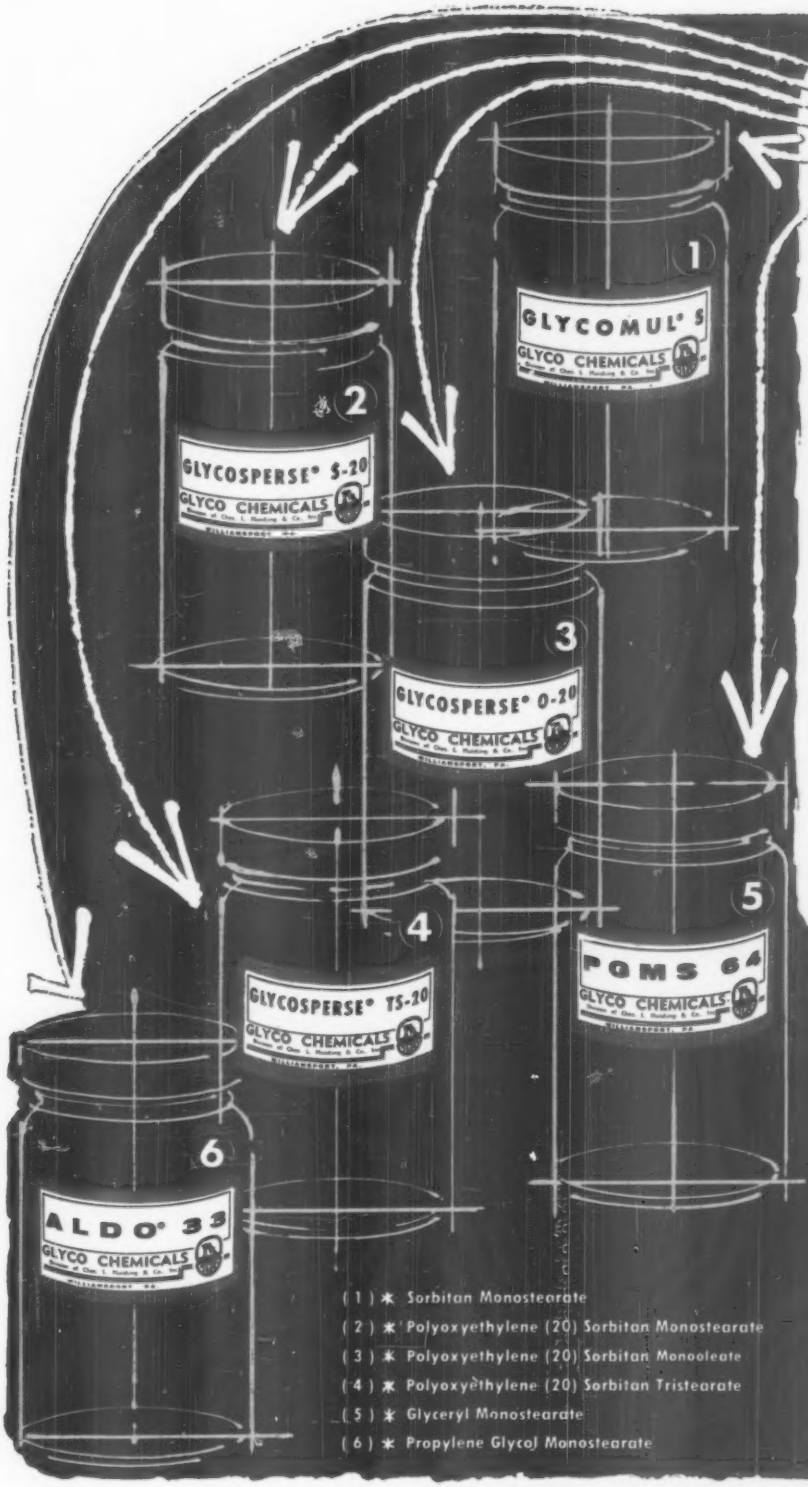
Magness, J. R. 1920. Composition of gases in intercellular spaces of apples and potatoes. *Botan. Gaz.* **70**, 308–316.

Sellers, W. S. 1918. U. S. Patent No. 1,279,379, Sept. 17.

Snedecor, G. 1957. "Statistical Methods." p. 251. Iowa State College Press.

Tressler, D. K., and M. A. Joslyn. "Fruit and Vegetable Juice Production." pp. 526–530. Avi Publ. Co.

Zilva, S. S., T. N. Morris, and E. O. V. Perry. 1935. Preservation of vitamin C in canning fruits and vegetables. Gt. Brit. Dept. Sci. Ind. Research Rept. Food Invest. Board 1934, 203.



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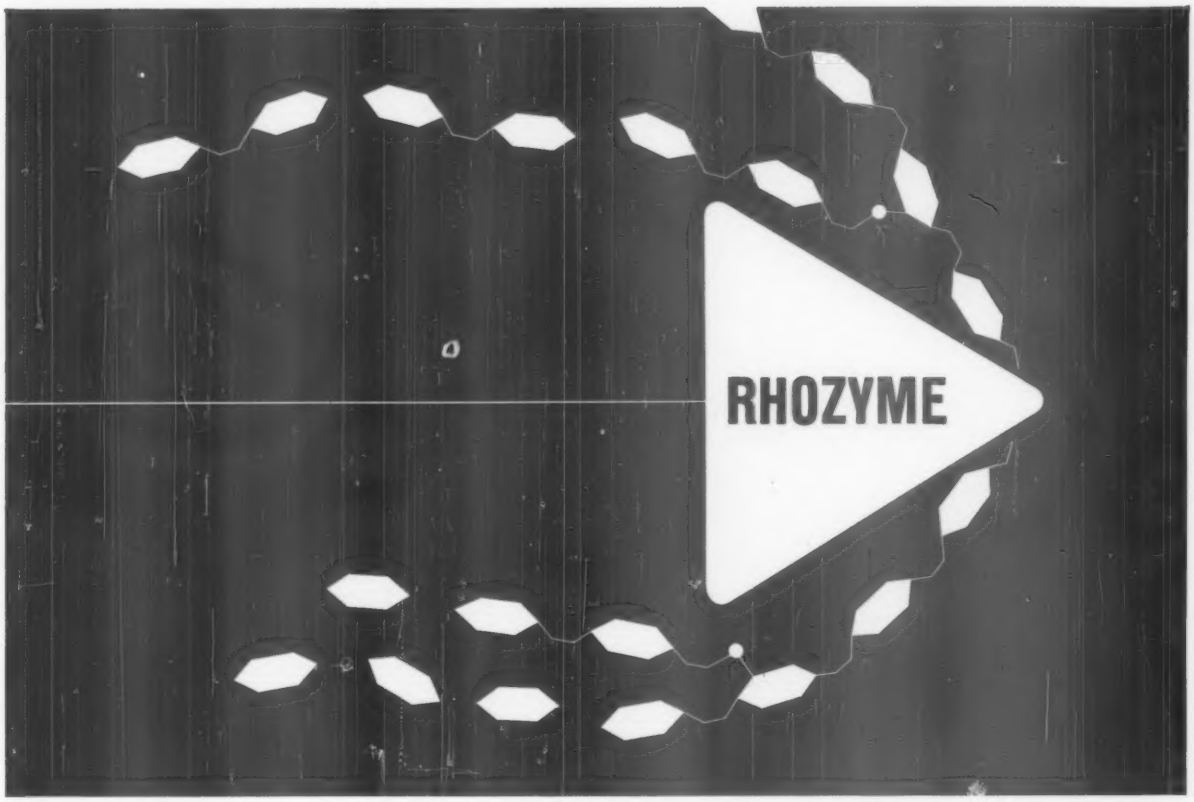

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Institute of Food Technologists

The Institute of Food Technologists, the professional society of Food Technologists, numbers among its active members leading scientists, technologists and engineers in the field of Food Technology.

The Institute invites your professional association with this select group of scientific and technological workers. Only those who are qualified by education, special training, or experience are extended this invitation.

Food Technology may be defined as the application of science and engineering to the production, processing, packaging, distribution, preparation and utilization of foods. Scientists, technologists and engineers engaged in Food Technology, executives, officials and supervisors under whose jurisdiction Food Technology operations are conducted, research investigators, teachers, and others working in the field of Food Technology, will find membership in the Institute worth many times its modest cost.

If you can meet the qualifications for membership, you owe it to yourself and to your business or profession to become a member.

OBJECTIVES

The Institute is a non-profit, professional, educational association to promote the application of science and engineering to the production, processing, packaging, distribution, preparation, and utilization of foods; it stimulates investigations into technological problems arising therein, it provides a medium for presenting and discussing the results of such investigations; it stimulates and provides means for the free interchange of technological information and ideas among food technologists; it promotes recognition of the role of food technologists in the technical direction of operations in these fields; all of these activities have the ultimate objective of providing better and adequate foods for mankind.

ORGANIZATION AND PROGRESS

Organized July 1, 1939, at Cambridge, Mass., with a membership of less than 100, the Institute has grown to more than 6,400 (1961). It is world-wide in scope, with members in North, Central, and South Americas, the Scandinavian countries, England, Holland, Germany, France, India, Australia, New Zealand, and Japan.

MEMBERSHIPS

Professional Members. Any person who is ethically qualified, and who has had training and experience in food technology, or any person who in the opinion of the Council is recognized as distinguished in the contributing sciences as they apply to foods, shall be eligible to be a Professional Member of the Institute. The minimum training which shall qualify a candidate for eligibility for Professional Member is, in general, graduation from a college, university, or similar institution in which he has majored in one or more of the sciences or branches of engineering associated with food technology. The minimum experience shall be three years experience in food technology. The Council may, at its discretion, waive any or all of the foregoing requirements in the case of a person who, thru long experience has distinguished himself in the field of food technology.

Members. Any ethically qualified person, active in special or limited aspects of food technology, who is an administrator, director or executive under whose jurisdiction operations in food technology are conducted; or who is engaged in the dissemination of knowledge of food technology; or one whose work requires a general knowledge of the broad principles of food technology as it applies to the products, processes or equipment with which he or she is concerned; or one scientifically trained in and who has entered a career in food technology; shall be eligible to become a Member.

Student Members. Any ethically qualified person who has never been a Professional Member or Member of the Institute, who is registered as a student in an educational institution with at least Junior (third year) standing, who is a candidate for a Bachelor's or higher degree in one or more of the sciences or branches of engineering associated with food technology, shall be eligible for membership as a Student Member. This classification shall be his status only until the end of the calendar year in which he completes his schooling. When graduated and otherwise qualified as defined in the section on "Members," a Student Member may, upon application, be elected to Membership.

DUES

Professional Members and Members—$10.00 a year; Students—$2.50 a year. Subscription to Food Technology included.

PUBLICATIONS

The Institute publishes two journals, Food Technology and the Journal of Food Science. The first, published monthly, is devoted primarily to subjects of direct interest to membership, including research papers on food technology and engineering. The Journal of Food Science, published bi-monthly, is devoted exclusively to papers reporting basic research in food chemistry, biochemistry, biophysics, and microbiology, as well as nutrition, sensory evaluation and consumer acceptance.

REGIONAL SECTIONS

Where sufficient members (25 or more) live within commuting distance of a given point, a Regional Section may be established. Such Sections are able to hold meetings at more frequent intervals than the National group, thus affording the food technologists regular opportunities for an exchange of views and ideas with others in the area. There are presently 35 Regional Sections.

ANNUAL MEETINGS

Each year one of the regional sections acts as host to the Institute at an Annual Meeting. The program of this annual conference is designed to acquaint members with various phases of food production, processing and distribution, and to keep them abreast of current trends and technological developments. The speakers invited are those whose subjects will build a well-rounded program, of interest to the greatest number. Annual conferences are highlighted by exhibits of new equipment, processes and special ingredients.

AWARDS

The society administers the following awards:

NICHOLAS APPERT AWARD (Medal and $1,000). Each year the Institute makes this award to a person whose contributions to the food industry make him distinguished and outstanding in the opinion of the national jury.

BABCOCK-HART AWARD ($1,000). The purpose of this award, made by the Nutrition Foundation, is to encourage contributions to Food Technology which will have an influence on the nutritional well-being of the general population.

FLORASYNTH FELLOWSHIP AWARD. $1,000 granted annually to a young man or woman under 35 years of age, engaged in senior undergraduate or graduate work, as a candidate for an advanced degree, in recognized educational institutions in the United States or Canada, which is conducting fundamental investigations for the advancement of Food Technology.

GENERAL FOODS FELLOWSHIP AWARDS. Three Fellowships will be granted annually—no more than two to the same educational institution for the same calendar year, but will be renewable upon application to and approval by the Awards Committee of the Institute for a maximum of three years, in order to provide for continuity of studies leading to a doctorate degree, if the candidate so plans. However, candidates who plan only a year of research after obtaining the Bachelor Degree, or who plan to read for a Master's Degree, will not be excluded from these fellowship grants. Each Fellowship is worth approximately $4,000.

GERBER'S INSTITUTE OF FOOD TECHNOLOGISTS UNDERGRADUATE AWARDS. Six undergraduate Scholarships at $1,000 each, per year, intended to cover the last two school years leading to a Bachelor's degree in Food Technology, Food Engineering, or Food Science.

THE SAMUEL CATE PRESCOTT FELLOWSHIP. An engrossed plaque and $1,000 granted annually to an outstanding young man or woman for graduate studies in the general field of food science and food technology, at a recognized educational or research institution in the United States or Canada. The award is for one year and is not renewable.

DODGE AND OLCOTT SCHOLARSHIP. One renewable Undergraduate Scholarship each year at $1,000 and an engrossed plaque. To encourage Junior or Senior students in recognized institutions of the U.S.A. or Canada to take undergraduate work leading to a Bachelor's Degree in Food Technology, Food Engineering, or Food Science.

ALEXANDER E. KATZ MEMORIAL SCHOLARSHIP. $1,000 annually and an engrossed plaque to a deserving and outstanding undergraduate. Designed to encourage these students to take courses leading to a Bachelor's Degree in Food Technology, Food Engineering or Food Science.

IFT SCHOLARSHIPS

The Institute also provides ten $300 scholarships to deserving college freshmen interested in the field of food technology.

Announcement

Thirteen Valuable Persons Wanted to Share $22,000 in Awards

THIRTEEN is a lucky number in the Food Technology field. That is the number of persons in the United States and Canada to be selected for the $22,000 worth of scholarships administered by IFT, which become effective during the 1962–63 school year.

The fellowships, scholarships, and awards are intended to encourage:

—graduate work in the field of food science and food technology

—undergraduate work leading to a Bachelor's Degree in Food Technology, Food Engineering, or Food Science.

GRADUATE LEVEL—FELLOWSHIPS

• **Florasynth Fellowship:** Sponsored by Florasynth Laboratories, Inc. The candidate must be under 35 years of age, a citizen of the U.S. or Canada, and must have a better-than-average scholastic record and/or a B.Sc. or equivalent, preferably with honor. The candidate must also have a demonstrated scientific or engineering aptitude together with an above-average interest in research. The awardee will receive $1,000 and an engrossed plaque. Nomination(s) for the fellowship shall be made only by *the head of the department* who supervises the work of the candidate(s), and should be made only on the official IFT Nomination Form.

Application for the following fellowships must be made by the *candidate personally* on the prescribed application form:

• **General Foods Fellowships:** Twelve thousand dollars is donated annually by the General Foods Fund, Inc., in the form of three General Foods Fellowships at $4,000 each, with an engrossed plaque to each awardee. Canadian or U.S. citizenship requirements apply. Applicants must be either on a senior undergraduate or graduate level in recognized educational or research institutions in these two countries. They should intend to pursue graduate work in basic or applied chemistry, chemical engineering or related sciences. This work may involve new physical or other procedures, aimed at extending or improving knowledge in some phase of food conservation, food production or food processing (rather than being primarily for research in the fields of nutrition, bacteriology or analytical chemistry). The applicant shall have an approved plan of research by the graduate school of the institution in which he proposes to hold the fellowship. Each application shall be accompanied by a letter from the head of the department where the applicant proposes to do his work. It must accept for the school responsibility connected with the fellowship, and state that the applicant is acceptable to the department. The award is renewable upon application and approval for a maximum of three years.

• **Samuel Cate Prescott Fellowship:** An award of $1,000 and an engrossed plaque, of which the IFT is the donor. The purpose is to encourage graduate work in the field of food science and food technology. There are no nationality requirements for eligibility, but the student must be presently at a recognized educational or research institution in the U.S. or Canada, engaged in senior undergraduate or first year graduate work. The award shall be for one year only and is not renewable.

UNDERGRADUATE SCHOLARSHIPS AND AWARDS

Eight thousand dollars worth of undergraduate awards and scholarships valued at one thousand dollars each will be made this year:

- **Gerber's Institute of Food Technologists Undergraduate Awards:** Six awards, $1,000 each, with an engrossed plaque; donated by The Gerber Baby Food Fund, Inc.
- **The Dodge and Olcott Scholarship:** One $1,000 scholarship and engrossed plaque; donated by Dodge and Olcott Inc.
- **The Alexander E. Katz Memorial Scholarship:** One $1,000 scholarship and engrossed plaque; donated by F. Ritter & Company

Qualifications and aims of the above awards are similar. They are intended to cover the last two school years leading to a Bachelor's Degree in Food Technology, Food Engineering, or Food Science. The awards shall be made to deserving and outstanding U.S. or Canadian citizens of at least second year standing in recognized educational institutions in these two countries. The awards will be continued for the second year only upon satisfactory performance by the student.

The curriculum of the department wherein the award is to be held must be approved by the donors.

For an applicant to qualify, he or she must have satisfactorily completed, prior to the effective date of the award, two full years of college work that will adequately prepare a student to complete the Junior and Senior years of a Food Technology course that is the equivalent of the model curriculum approved by the Institute of Food Technologists (see FOOD TECHNOLOGY, Vol. 12, No. 9, 1958). Candidates will be judged on over-all ability including scholarship, personality, extracurricular activities, social adjustment, and character.

DEADLINE for receipt of applications and nominations for all awards, and the accompanying photographs and letters of recommendation, is March 1, 1962. They must be received by IFT by that date. Submit all requests for application and nomination forms, questions and correspondence, and the completed applications to: Executive Secretary, Institute of Food Technologists, 176 West Adams Street, Chicago 3, Illinois.

"We don't want Citric Acid

"One-supplier" dependence . . . no matter how good that supplier . . . is clearly a dangerous practice — says Howard F. Roderick, President, Miles Chemical Company.

We used to be dependent on just one supplier for citric acid. For obvious reasons, we didn't like it. Because no one supplier is completely safe from trouble. Fires, floods, process problems, transportation difficulties and national emergencies can cripple any supplier's ability to serve your important needs.

To beat this "one-supplier" situation we began manufacturing citric acid to fill our own needs. And we built plenty of extra capacity to help relieve other users from supply pressures. Because Miles has invested over $12 million in plant and development costs, industry now, for the first time, has the extra protection of competitive buying for this vital commodity.

Reactions to this important step have been interesting. Some buyers, like Miles, are deeply concerned over the "one-supplier" relationship. They react by dividing their business on a rational basis.

Others move in the same buying-habit patterns as if unaware that the market now offers freedom of choice and all the opportunities which this new condition implies.

all of your business"...

We feel a word of caution is in order. Anything approaching total dependence on one supplier . . . even if we are that supplier . . . is a dangerous purchasing practice.

May we suggest that you examine your company's citric acid buying plans? The market has changed. Have your people taken the extra measure of caution which this new broadened market situation warrants?

Miles products for the industry:

In addition to citric acid, Miles Chemical Company can fill your needs for sodium citrate, for fine organics, or antioxidants, and can provide the widest choice of commercial enzymes available from any supplier. For information about any of these products write Miles Chemical Company, Division of Miles Laboratories, Inc., Elkhart, Indiana.

"Competitive buying from well-qualified suppliers remains the purchaser's best protective measure."

Dean Ammer, Executive Editor of *Purchasing* Magazine, when queried for an opinion on competitive buying, responded: "Competitive buying from well-qualified suppliers remains the purchaser's best protective measure. That this procedure is a cardinal rule of good purchasing practice is reflected in the written purchasing policy of practically every leading manufacturer. In no other way can the purchaser be confident of the most reasonable price for the quality he requires . . . nor . . . as importantly . . . can he have protection of vital supplies in times of crises in the market."

MILES CITRIC ACID

C-9-1

Book Reviews

PRODUCTION AND APPLICATION OF ENZYME PREPARATIONS IN FOOD MANUFACTURE. S. C. I. Monograph No. 11. Society of Chemical Industry. London. 1961. 180 pages.

This small volume comprises the papers (with discussions) presented at a symposium organized by the Food Group and held on October 1–2, 1959, at the Royal Society of Medicine, London. Except for Dr. L. A. Underkofler, Miles Chemical Co., Clifton, New Jersey, all the participants were from England.

Dr. M. Dixon, of world renown as an enzymologist, opened the symposium with a brief, general introduction to enzymology, particularly to the groups of enzymes of interest to the food technologist. Papers of the remainder of the first session and all the second session were devoted to a discussion of the production, properties, and uses of fungal amylase, invertase, pectin-degrading enzymes, proteinases, and glucose oxidase. Especially well presented and authoritative are the papers by Dr. W. W. Reid, on pectin-degrading enzymes, and by Dr. L. A. Underkofler, on plant and microbial proteinases and on glucose oxidase.

Papers of the first part of the third session are reviews of the action and control of innate enzymes in fruit ripening and in the processing and storage of fruit juices and other fruit products. The paper by Dr. A. C. Hulme, on enzymes concerned in the ripening of fruits, should be of general interest to the horticulturist as well as to the food technologist.

The remainder of the third session and the fourth session were devoted to papers on the deteriorative effects of enzymes, including a discussion of the nature and action of ascorbic acid oxidase, polyphenol oxidase, and enzymes associated with the hydrolysis and oxidation of lipids in plants and animals.

The book should appeal to a rather wide readership in food technology and related areas. The producer of enzymes, the food manufacturer, and the student of food technology will find it particularly useful. It is written so that all may profit by its use. The book, though attractively bound and printed on good-quality paper, does suffer from not having a subject and author index at the end.

JOHN R. WHITAKER

THE ENCYCLOPEDIA OF THE BIOLOGICAL SCIENCES. Peter Gray, ed. Reinhold Publishing Co., New York. 1961, 1119 pp. Price $20.

By the editor's definition, this one-volume encyclopedia is "intended to provide succinct and accurate information for biologists in those fields in which they are not themselves experts." Within the limits imposed by the one-volume format, this objective is achieved to a surprising degree. Coverage is far from complete either as regards the number of topics given separate articles or the depth to which a given topic is explored, but the person seeking a brief exposition of a biological subject outside his own field will do well to make this encyclopedia his first port of call. The search for additional enlightenment is assisted by the list of references given with almost every article, directing the reader to sources of more copious information on the topic.

There is some unevenness in the quality of both the prose and the thought in the articles that make up this compendium, but this is rather less than might be expected from a volume whose contributors range from graduate students to Nobel laureates and whose geographical and educational backgrounds cover the globe. Each of the contributors has the virtue of being a specialist in his topic, and many of the authors are associated with important recent advances in the field they discuss.

The book is well manufactured, with an attractive binding and a clear and readable, although necessarily small, type face. Illustrations are confined to those necessary for clarity of exposition, but both line drawings and half-tones are well reproduced and large enough to present the necessary detail.

The index could be more helpful in finding subjects hidden within the body of an article on another topic, and some ingenuity may be required in ferreting out the relationships the indexer had in mind. A little search (and some inspired guessing) will usually lead one to the information he desires.

This is not a volume that every food technologist should have on his shelf, but those whose interests range widely in the biological sciences or whose work brings them into contact with unfamiliar fields will be able to spend a few minutes cramming or many happy hours browsing in the wealth of biological fact and theory gathered here.

R. T. WEDDING

SCIENTIFIC THINKING AND SCIENTIFIC WRITING, by Martin S. Peterson. Reinhold Publ. Co. New York. 1961, 240 pp. Price $6.95.

The recent interest in books that consider the problem of style in writing, points to certain characteristic deficiencies in many secondary schools. In few instances do students learn to write with economy and precision. In even fewer instances do they follow grammatical custom. Hand-in-hand with these deficiencies is an ignorance of the logic of exposition. Potential scientists are not exposed to the formal principles of logic until their college careers. Even then, few prospective Doctors of "Philosophy" will elect to take a course in philosophical thought, let alone one in the methods of logic.

From a vantage point gained by more than eight years' experience as editor of *Food Technology* and *Food Research*, Dr. Peterson has constructed a text that attempts to supply this missing background in logic. Essentially, he has put into writing that which many scientists may intuitively perceive—and which some "scientists" are not able to recognize at all.

This is a text for the graduate student who is planning experiments and who will be organizing his results for publication. It deals principally with the logic of the experimental plan, the creativity of the

worker, and the organization of the technical paper that issues from the experiment. To the reviewer's delight, Dr. Peterson has included, with careful explanation, Mill's classical canons of inductive logic. Although not indicated by that name here, these principles are, of course, the generally unrecognized philosophical basis of the so-called "scientific method."

Other considerations of interest to the young scientist—and the older one—include the writing of review papers, essays, and book reviews. Recommendations are given for note-taking and general library habits. A most welcome feature of the book is the use of articles from journals to serve as models for each type of writing discussed.

Dr. Peterson's book is a good addition to the library of the graduate science student. "Post-graduate" scientists also could probably read it with profit.

CLARENCE STERLING

IFT SECTIONS: R.S.V.P.

Section officers are invited to submit news of their Section's activities for publication in FOOD TECHNOLOGY. Special meetings, headline speakers, details of important talks by speakers, reports of past meetings and election of officers are particularly welcome. Submit to: Executive Secretary, Institute of Food Technologists, 176 West Adams Street, Chicago 3, Illinois.

About *JFS

The JOURNAL OF FOOD SCIENCE publishes research articles of the highest quality that report results on these subjects:

Foods and Food Components

- . . . Biochemistry
- . . . Chemistry
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IFT News

International

AUSTRALIA NORTHERN SECTION NAMES NEW OFFICERS

New officers and committee members of the Australia Northern Section IFT were announced at the Section's 11th Annual General Meeting, held recently:

Chairman—Jack Shipton (C.S.I.R.O.).
Vice-Chairman—Bob Bottomley (Mauri Bros. and Thomson).
Secretary—Peter Crocker (Albright & Wilson).
Treasurer—David Lewis (Henry Lewis & Sons).
Committee Members
(2-year term):
Max Martin (Cottees)
Jack Kefford (C.S.I.R.O.)
Ron Edwards (Univ. of N.S.W.)
(1-year term):
Ron Edwards (Qantas)
Miss Christie (C.S.I.R.O.)
John Williams (Wm. Arnott)
Auditors—Peter Muller (W. J. Bush)
Wal Hopkins (Henry Jones Ltd.)

VOLUNTEERS FOR INTERNATIONAL TECHNICAL ASSISTANCE, INC.

VITA is an organization of scientists, engineers, and other technical specialists personally interested in volunteering technical assistance to the less-industrialized countries of the free world.

The organization is entirely voluntary, and operates on a non-profit basis. It has recently appealed to IFT President-Elect John M. Jackson for support.

A large number of the requests for assistance concern the development of a new technique or device; for example, the use of plastics in home canning, and low-cost solar cookers.

Because of the vast number and variety of problems continually flowing to VITA for solution, an urgent need exists for more technically trained people who will work on a volunteer basis.

Further information may be obtained from VITA, 1204 Eastern Avenue, Schenectady 8, N. Y.

National

MAX DUNN RECEIVES SCIFT AWARD

Dr. Max S. Dunn, Associate Dean of the Graduate Division, Professor of Chemistry, and Professor of Physiological Chemistry, University of California (Los Angeles), received the Southern California Section IFT 1961 Food Science Award. Dr. Dunn has served IFT in many responsible positions over the past 15 years.

Dr. Dunn has been a member of the faculty of the Department of Chemistry, UCLA, since 1921. His interest in problems of food and nutrition, and his research on the chemical, physical, and nutritional properties of the amino acids did much to make him the recipient of the award.

IFT COUNCIL ACTIONS

The Executive Committee of the Council met in special session on August 29th for the primary purpose of evaluating a Public Relations program as proposed by the Institute's Public Relations Counsel. However, in addition to this item, several other matters were discussed, and those requiring Council approval were submitted to that body, by ballot, for vote. A brief discussion of each recommendation, and the Council action, follow:

It was reported that a new Directory of Members is now being compiled and that the Directory should be available to the membership late in January or early February 1962.

(No action required)

A report was submitted on the returned ballots which were sent to the membership with regard to the name of the Institute. The results of the opinion survey are:

949—Institute of Food Science and Technology
631—Institute of Food Technology
583—Institute of Food Science
1,234—Institute of Food Technologists

Since there is no clear-cut expression of opinion, and since there was some opposition to the word "Institute," it was recommended that another ballot (for expression of opinion only) be sent to the membership, offering a choice as to "Institute" or "Society" and "Food Science and Technology" versus "Food Technologists," along with a letter explaining the pros and cons of each.

(Approved by Council)

The Executive Committee approved a recommendation in relocating the 1963 Annual Meeting from Grand Rapids, Michigan, to Cobo Hall, Detroit, Michigan, because of the growth of IFT Annual Meetings and the lack of adequate facilities in Grand Rapids. The meeting is to be scheduled during the week of May 26th.

(No Council action required)

It was recommended that the Institute name official delegates to the First International Congress of Food Science and Technology, which is scheduled in London for September, 1962. The President, Immediate Past-President, President-Elect, Executive Editor, and Executive Secretary were so designated, and travel funds were appropriated for this purpose.

(Approved by Council)

The proposed new format for *Food Technology* was approved by the Committee on Publications and the Executive Committee, and it was recommended that a staff member be engaged to handle the production and layout of the Journal. Changes in format will begin to be effected with the January, 1962, issue.

(Approved by Council)

The Executive Committee reviewed in detail the Public Relations Program as proposed by the

Public Relations Counsel and the Ad Hoc Committee on Public Relations, and was in general agreement with the Program, and felt it to be worthy of financial support and implementation. It was recommended that funds be allocated in this year's budget for this purpose.

(Approved by Council)

It was proposed that funds be allotted to finance the cost of air-conditioning the Institute offices.

(Approved by Council)

The Executive Committee recommended the establishment of a policy with respect to air travel for Officers, Committee, and staff members of the Institute. *When authorized*, officers, committee chairmen or members, or employees traveling by air on Institute business will be eligible for reimbursement only in the amount of tourist fares (including tourist jet surcharges) except in those instances where it can be proven that first-class flight was necessary.

(Approved by Council)

UNDERGRADUATE CURRICULA IN FOOD COURSES TO BE REVIEWED AT EDUCATIONAL CONFERENCE

The second conference to study curricula and courses in four-year programs in food science and technology under the sponsorship of the IFT committee on education will be held February 12 and 13, 1962, at Kellogg Center, Michigan State University, East Lansing, Michigan.

The tentative program centers on three major subjects.

The first will deal with how well the challenge of undergraduate training in food science and technology is being met. University programs and courses will be reviewed and studied in relation to the "Model Curriculum" proposed in the report of the First Educational Conference held at Allerton House, Monticello, Illinois, May 21–23, 1958 (*Food Technology* **12**(9), p. 7 (Adv. Sec.). All universities and colleges with four-year curricula in Food Science and Technology have been requested to provide information on their staff, numbers of students enrolled, curriculum organization, and course offerings.

The second subject will direct attention to basic courses that may be considered the core of the curriculum, and that are required of all students. Such courses as food chemistry, food microbiology, and food engineering will come under critical examination in order to improve the presentation of these important subject-matter fields.

The third subject will be devoted to student recruitment programs. These will be discussed in relation to the roles played by the universities, industry, government agencies, IFT, and other organizations. The committee will also consider the training of foreign students. Counsel will be sought from industry in all phases of this important session.

Representation at the conference is sought from all phases of education and industry concerned with the teaching of food science and technology at the undergraduate level. Further information may be obtained from Dr. B. S. Schweigert, chairman, IFT Committee on Education, Department of Food Science, Michigan Sate University, East Lansing, Michigan.

Government Action

FDA WHOLE FISH FLOUR PROPOSAL

In mid-September, the Food and Drug Administration proposed establishment of a definition and standard of identity for fish protein concentrate and whole fish flour.

The proposal resulted from a visit to FDA by a manufacturer who stated that a process had been developed by him for manufacturing a fish flour product that could be used as a source of protein, and marketed at a price "that would be most attractive when compared with the cost of other sources of protein."

The "whole fish flour" would be made from grinding various-sized whole fish, removing the fat by chemical process, and drying the flour.

FDA informally expressed the opinion that the proposed "whole fish flour" should be regarded as an adulterated article under the Federal Food, Drug, and Cosmetic Act, because it was to be made without removing those portions of the fish, including the intestines and their content, that are normally regarded as unacceptable for human food in the U. S.

Proponents of the product disagreed with the FDA opinion, and felt that if consumers in general were fully informed of the nature of the product they would accept its use.

The proposed FDA standard includes these specifications:

1. Protein content, measured by methods of the Association of Official Agricultural Chemists, shall not be less than 70 percent by weight of the final product and biological values of the final fish protein concentrate.

2. Moisture and ash contents shall not exceed 6 percent and 25 percent by weight of the final product.

3. Fat content shall not exceed one percent.

4. The final product should have no more than a faint fish odor and taste, and when baked in bread in the ratio of one part of fish protein concentrate to 11 parts of grain flour there should be no detectable fish odor or taste.

5. The fish protein concentrate, after six months of storage at temperatures prevailing in areas of intended use, but not exceeding 100 degrees F, packed in metal containers or in polyethylene bags, should show no spoilage as judged by the development of off flavors, mold growth, production of toxic amines, or by deterioration in protein quality as shown by digestibility and available lysine values below the specific minima.

FDA has invited comment from both consumers and industry on the proposal. Comments should be made in writing to the Hearing Clerk, Department of Health, Education, and Welfare, Room 5440, 330 Independence Ave., S.W., Washington 25, D. C.

Letter from the Editor

Dr. D. K. Salunkhe, Department of Horticulture, Utah State University, has asked us to search among our readers for those who may have encountered the problem of an unusual softening and discoloration of Montmorency cherries during the early stages of processing. These phenomena have caused severe financial losses to some Utah growers and processors, according to Dr. Salunkhe.

In asking for ideas or experiences connected with the problem, Dr. Salunkhe writes that the University's attention to the matter came through a fruit processor who reported that Montmorency cherries from four orchards were graded by the state inspector at his plant as extra fancy (high quality). However, when these cherries were soaked in water—a regular processing practice in an attempt to firm the fruit and facilitate pitting—the cherries became progressively whitish within a few hours, and in the pitting process they became very soft and subsequently turned brown. The grade of the product to be frozen became poor. This rapid change from excellent to poor quality took place within 2 to 3 hours. A similar, but more drastic, phenomenon was evidenced in cherries harvested from yet another orchard. When soaked in tap water for a few hours the pits rested at the bottom of the tank, while the brown flesh and skin floated at the top.

The cherries were treated with calcium chloride and alum in an attempt to inhibit softening, and with ascorbic acid to inhibit browning. It was also thought that the softening, decoloration, and subsequent discoloration might be the result of microbial growth; hence, the cherries were treated with D.H.A.-S and potassium sorbate. No beneficial effects, singularly or cumulative, were evidenced from these treatments.

Continuing, Dr. Salunkhe states that the disorder was discussed with several experienced growers and processors, Utah State University faculty members, Dr. John Brekke, Food Technologist at the Western Regional Research Laboratory, Albany, California, and Dr. Charles Bedford, Professor of Food Technology, Michigan State University.

It was suggested that the malady might be due to the angle of sprinkler irrigation, which might have caused physical damage to the fruits, and the damage accelerated upon soaking in water. It was also suggested that the malady might be due to high fertility of the soil; however, the orchards had not been fertilized in the past four years. The possibility was also considered that powdery mildew might be the cause of softening; however, examination of the orchards showed that powdery mildew was not present. The age of the orchard was given consideration, because tender fruits are

SENTRY Food Preservatives inhibit mold growth! Extend keeping-life by controlling spoilage

It's easy, these days, to take out insurance against "customer letdown . . ." Just add a little SENTRY sorbic acid or potassium sorbate to your food products—and keeping-life is extended for days—on the store shelf and in the home.

That's because SENTRY sorbic acid and potassium sorbate preserve quality and appearance better than any other commercial fungistats. Flavor, aroma and color aren't affected because less than 0.1% concentration does the job effectively . . . and *economically*. Help protect natural and process cheeses in cuts and slices in consumer-size packages, baked goods, fruit juices, citrus products, soft drinks and fountain syrups, wines, pickles, dried fruits, salads—dozens of other packaged and refrigerated goods.

SENTRY Food Preservatives are compatible with almost any food product. Completely safe, too—digested in the same way as butter fat.

Try SENTRY Food Preservatives in your products: SENTRY sorbic acid—a snow-white, free-flowing powder; SENTRY potassium sorbate—the highly water-soluble salt of sorbic acid. *For test samples* and full information write Union Carbide Chemicals Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, New York.

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UNION CARBIDE CHEMICALS

usually produced in young orchards. Another theory was that these unusual changes in the cherries during early processing could be due to the high temperatures (over 100°F) just prior to harvest, which may have "cooked" the tender fruits on the trees; and upon putting the cherries in cold water the biochemical reactions that are responsible for softening and discoloration of anthocyanins may have accelerated.

Any of our readers who would care to contact Dr. Salunkhe may do so through the Department of Horticulture, Utah State University, Logan, Utah.

In bringing the above to the attention of our readers, it is hoped that *Food Technology* will continue to perform a useful service in the important exchange of all phases of information, and it is further hoped that these pages will always be instrumental in the advancement of food science.

GEORGE F. STEWART
Executive Editor

Equipment & Supplies

LOW-COST WATERPROOF LIMIT SWITCH

A low-cost waterproof precision snap-action limit switch capable of underwater operation has been developed by Controls Company of America.

The new switch, engineered for a minimum life capacity of 1 million cycles, has been actuated 200 thousand times with full overtravel under one-inch head of water without leaking.

Key element of the new watertight switch is the plunger, made of delrin, which is sealed in a specially designed neoprene boot. The outer case is nylon.

The switch is available with wire leads potted in epoxy resin or spade terminals. The complete line of actuators available snap on to the case.

For further information, address Industrial and Commercial Controls Sales Department, Controls Co. of America, 9555 Soreng Avenue, Schiller Park, Ill.

NEW TRUCK REFRIGERATION SYSTEM

A system that uses liquid carbon dioxide as a refrigerant in truck and truck trailer bodies, and is said to provide increased reliability and a considerably lower temperature range than is now available in mechanical units, is announced by the Cardox Division of Chemetron Corporation.

In operation, carbon dioxide is carried in tanks suspended under the truck body and piped directly to the truck's interior. The liquid can provide temperatures down to minus 60 degrees F or lower.

The new system can pull truck temperatures down at the rate of one degree a minute—considerably faster than with mechanical refrigeration.

Because the new system has no moving parts, the chances of breakdown are reduced.

NEW LIFT... LONGER LIFE FOR YOUR PRODUCTS WITH FIRMENICH POWDERED FLAVORS

New and improved techniques of process drying, exclusively employed by Firmenich, yield powdered flavors that flow freely, are dust free, and give you the finest precision in flavoring your products. These important developments in quality flavoring will improve the taste appeal of your products . . . extend their shelf life . . . give them package-to-package uniformity that captures customer preference. Samples of Firmenich Powdered Flavors, with technical information on their practical application, on request.

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Chemicals

CHEMICAL ADDITIVES FOR POULTRY

U.S.D.A. proposes to establish uniform procedures to be used by industrymen seeking approval for the use of chemical additives in poultry products processed under Federal inspection.

The proposal was published in the Federal Register of Sept. 2nd.

Raw Materials

NEW RESEARCH LABORATORIES

New laboratories for basic research on post-harvest physiology of fruits and vegetables have been established by the U.S.D.A. at the Plant Industry Station, Beltsville, Md.

Research will be aimed at developing basic information on physiological changes associated with the ripening and aging that occur in fruits, vegetables, and other plant material after harvest under marketing, storage, and transport conditions.

Key scientists assigned to the new labs are Drs. Morris Lieberman, Charles C. Craft, and James E. Baker.

Packaging

SPACE FEEDING CONTAINERS IN PRODUCTION

Containers that have been modified for human use in space flight and permit easy consumption of a variety of foods in a weightless environment are now in production. Because of weightlessness, food must be ingested directly (container to mouth); otherwise the food will float into space within the ship.

The metal space feeding container resembles the standard 6-ounce concentrate can, with both of its ends so constructed that a plastic piston is incorporated for easy and efficient removal of foods and beverages. The container lining is coated to preserve foods of varying acidity, and the container itself will withstand temperatures ranging from zero to 190°F.

Space food, in chunk and bite sizes, is heat-processed and vacuum-packed to create an equilibrium with the one-half atmosphere common to a space vehicle—15 inches of vacuum. The cans are hermetically sealed.

Hot meals of meat and vegetables are prepared by removing plastic reclosures, covering both ends of the can, prior to heating in a three-cavity oven for about 30 minutes at 170°F. When the food is ready to eat, the top of each can is removed and a special mouthpiece is attached to the opening. A plunger-like device is then attached to the bottom of the can. This metal unit breaks the bottom of the scored can and forces the food into the mouth by means of a plastic piston.

An experimental space kitchen has been designed that will store, refrigerate, and heat all foods and beverages needed by a three-man crew on a 14-day outer-space flight.

The space feeding development is a joint project of Continental Can Company's Metal Research and Development Department, Chicago, and Whirlpool Corporation, St. Joseph, Michigan.

The complete space feeding apparatus. Food can with plastic reclosures is at right.

People

Robert L. Klein has been appointed manager of the Chicago Division of Durkee Famous Foods. He succeeds **George F. Atkinson,** recently appointed vice-president and general manager of Durkee Foods Group Edible Oil Products Division. Klein, who joined Durkee in September, 1960, was previously vice-president of the Capital City Products Co., Columbus, Ohio.

Oscar Skovholt, 64, for the past 25 years Director of Laboratory Services, Quality Bakers of America, died September 21 following surgery. Dr. Skovholt, recognized authority in the field of cereal chemistry, was instrumental in developing improved methods of evaluating bakery ingredients.

George A. Milton, Sr., 72, died at St. Francis Hospital, Roslyn, N. Y., September 28. Founder and past president of the can manufacturing company bearing his name, Milton was also one of the founders of the Can Manufacturers Institute, Washington, D.C., and served as its president in 1948–49. He was an honorary member of the Institute's Board of Governors at the time of his death.

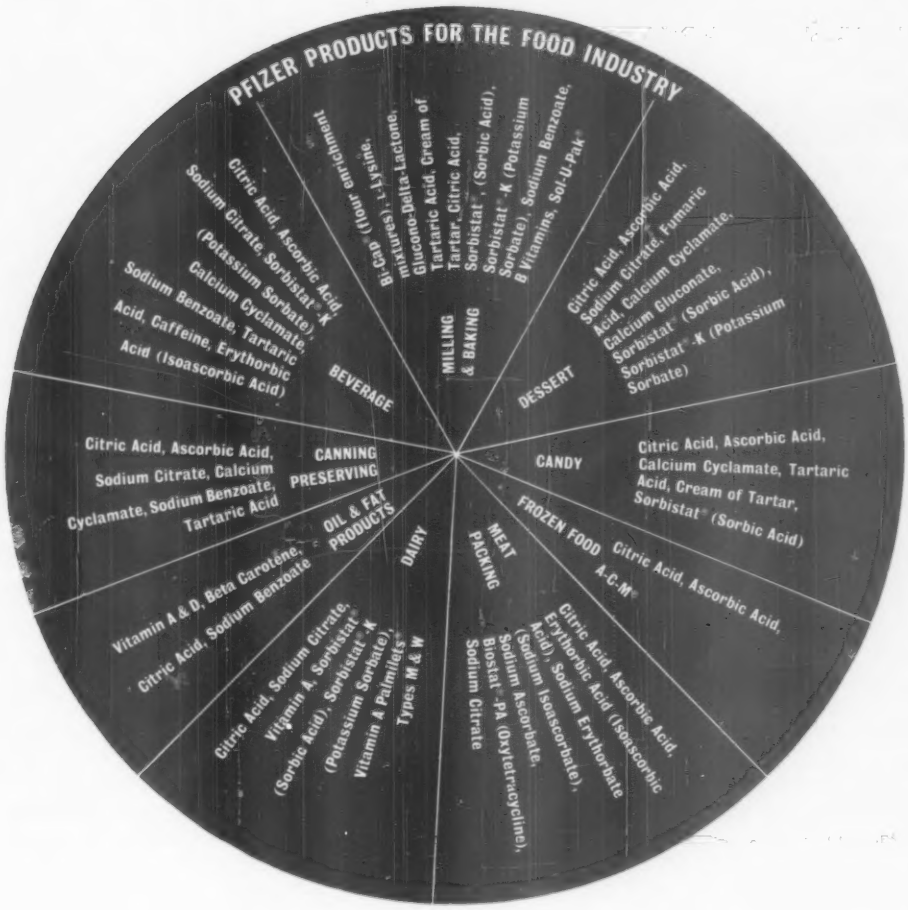
Mona Oser, vice-president of the Food and Drug Research Laboratories, Inc., Maspeth, N. Y., was the guest of honor at a recent reception at Forest Hills Inn to commemorate the 35th anniversary of her association with the laboratories. Prior to her present office, Miss Oser served FDRL successively as biologist, chief biologist, and administrative assistant.

Arnold F. Cornett and **James Dubberly** have joined the sales staff of Wm. J. Stange Co., nationwide spice, seasoning, and food-coloring manufacturers. Cornett will be headquartered in Los Angeles. Dubberly will cover a new territory for Stange in Louisiana, Arkansas, Mississippi, and Tennessee.

A. F. Cornett

J. Dubberly

What will the foods of the future be like
!


PFIZER PRODUCTS FOR THE FOOD INDUSTRY
MILLING & BAKING
Bi-Cap (flour enrichment mixtures), L-Lysine, Glucono-Delta-Lactone, Cream of Tartaric Acid, Tartar, Citric Acid, Sorbistat®, (Sorbic Acid), Sorbistat®-K (Potassium Sorbate), Sodium Benzoate, B Vitamins, Sol-U-Pak®
DESSERT
Citric Acid, Ascorbic Acid, Sodium Citrate, Fumaric Acid, Calcium Cyclamate, Calcium Gluconate, Sorbistat® (Sorbic Acid), Sorbistat®-K (Potassium Sorbate)
CANDY
Citric Acid, Ascorbic Acid, Calcium Cyclamate, Tartaric Acid, Cream of Tartar, Sorbistat® (Sorbic Acid)
FROZEN FOOD
A-C-M®
Citric Acid, Ascorbic Acid,
MEAT PACKING
Citric Acid, Ascorbic Acid, Erythorbic Acid (Isoascorbic Acid), Sodium Erythorbate (Sodium Isoascorbate), Sodium Ascorbate, Biostat® PA (Oxytetracycline), Sodium Citrate
DAIRY
Citric Acid, Sodium Citrate, Vitamin A, Sorbistat®-K (Sorbic Acid), Sorbistat®-K (Potassium Sorbate), Vitamin A Palmitate, Types M & W
OIL & FAT PRODUCTS
Vitamin A & D, Beta Carotene, Citric Acid, Sodium Benzoate
CANNING PRESERVING
Citric Acid, Ascorbic Acid, Sodium Citrate, Calcium Cyclamate, Sodium Benzoate, Tartaric Acid
BEVERAGE
Citric Acid, Ascorbic Acid, Sodium Citrate, Sorbistat®-K (Potassium Sorbate), Calcium Cyclamate, Sodium Benzoate, Tartaric Acid, Caffeine, Erythorbic Acid (Isoascorbic Acid)

Whatever the form or content of tomorrow's foods, they will owe something to the research laboratory of today. If you are working to develop new food products, or to improve present ones, the end to your search may be as close at hand as your Pfizer representative.

The name Pfizer has been synonymous with highest quality ingredients and service for the food industry for more than 110 years. This reputation results, in no small way, from the contributions of Pfizer Technical Service.

Our customers have come to rely on our many products and on our readily available technical service "team" at every stage of product development—from research to finished production.

For example, when manufacturers of "convenience" mixes—general-purpose and specialty baked goods—wanted a more controlled type of leavening action, Pfizer offered Glucono-Delta-Lactone. This chemical leavening acid imparts no unpleasant aftertaste, yet helps provide products having excellent volume and fine even texture. G-D-L's high stability in storage also insures longer shelf life.

Mold and yeast growth had been causing food-freshness problems in cheese, wines, prepared salads, and baked goods. Today, Pfizer Sorbistat®-K and Sorbistat® provide the means to ensure a "stay fresher longer" quality in such products.

In the nutritional area, Pfizer L-LYSINE has made possible great strides in improving the protein quality of grain-based foods ranging from breads to breakfast cereals . . . without affecting the taste or texture of the product. This essential amino acid "activates" the protein potential present, thus improving the total protein quality.

These few examples merely typify Pfizer's experience and willingness to help. Let us prove that our products and personnel can help solve your problems.

If you have a food product problem, look to Pfizer first.

Science for the world's well-being®

Pfizer

CHEMICAL DIVISION

Chas. Pfizer & Co., Inc.
Chemical Division
New York 17, N. Y.

CALL FOR NOMINATIONS

The Babcock-Hart Award

Any member of the Institute of Food Technologists may submit a nomination for the 1962 Babcock-Hart Award between now and the January 1, 1962, deadline.

To be considered, nominations must be made on the prescribed nomination form, which may be obtained from the Executive Secretary.

Donor of the $1,000.00 and engrossed plaque accompanying the Award is the Nutrition Foundation. Purpose of the Award is: "To honor a person who has distinguished himself or herself by contributions to Food Technology which have resulted in improved public health through some aspect of nutrition or more nutritious food."

To be eligible, a nominee must have made a technological development, or a scientific contribution leading directly to a technological development, which favorably affects the nutritional well-being of the public. **Contributions in clinical nutrition and fundamental scientific studies in nutrition cannot be considered as qualifying according to conditions established by the Donor.**

The Nicholas Appert Award

Any member of the Institute of Food Technologists may submit a nomination for the 1962 Nicholas Appert Award between now and the January 1, 1962, deadline.

To be considered, nominations must be made on the prescribed nomination form, which may be obtained from the Executive Secretary.

Donor of the $1,000.00 honorarium accompanying the Award is the Institute of Food Technologists. The Award, originated by the Chicago Section, also includes a Bronze Medal, which is donated by that Section. Purpose of the Award is: "To honor a person for pre-eminence in and contributions to the field of Food Technology."

Qualifying criterion for a nominee includes merely the fact that the nominator considers the individual so pre-eminent in the field of Food Technology that he or she should be acclaimed for contributions thereto. This precludes consideration of personality or other characteristics outside the field of contributions to Food Technology, for such factors may not be considered by the Awards Jury in making the selection.

Coming Events

1962

Jan. 8–12	A Course in Civil Defense for the Food Industry, Indianapolis, Indiana. For further information contact Mr. G. M. Clark, Stokely-Van Camp, Inc., 941 North Meridian Street, Indianapolis 6, Indiana
Jan. 14–20	Food Industry Science School, Empress Motel, Asbury Park, New Jersey. For further information write Department of Food Science, Rutgers, The State University, New Brunswick, N. J.
Jan. 15–17	A Course in Civil Defense for the Food Industry, Ames, Iowa. For further information contact Dr. Richard H. Forsythe, Dept. of Poultry Husbandry, Iowa State University, Ames, Iowa
Feb. 5–9	41st Norelco X-ray Analytical School, Henry Hudson Hotel, New York City. For further information contact Philips Electronic Instruments, 750 South Fulton Avenue, Mount Vernon, N. Y.
Feb. 5–9	Recent Developments in Water Bacteriology —training course, Cincinnati, Ohio. For further information write Chief, Training Program, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio
Feb. 19–23	Laboratory Examination of Foods—training course, Cincinnati, Ohio. For further information write Chief, Training Program, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio
Feb. 27–28	Tenth Annual National Dairy Engineering Conference, East Lansing, Michigan. For further information write A. W. Farrall, Agricultural Engineering Department, Michigan State University, East Lansing, Michigan
Mar. 9–10	Tenth Annual Food Technology Short Course, Columbia, Missouri
May 10–12	International Symposium on Food Protection, Department of Dairy and Food Industry, Iowa State University, Ames, Iowa
June 10–14	**Twenty-second Annual Meeting of the Institute of Food Technologists, Fontainebleau Hotel, Eden Roc Hotel, Miami Beach, Florida**
Aug. 20–24	Commission 9 of the International Institute of Refrigeration. For further information write Dr. W. T. Pentzer, Agricultural Marketing Service, U. S. Department of Agriculture, Washington 25, D. C.
Sept. 8–16	Fifth International Food Congress and Exhibition, New York Coliseum. Further information about the Congress may be obtained from James Muckell, Secretary, Fifth International Food Congress Inc., 527 Madison Avenue, New York 22, New York
Sept. 18–21	First International Congress of Food Science and Technology, Imperial College of Science and Technology, London, England. For further information write Francis J. Griffith, Honorary Secretary, 14 Belgrave Square, London, S. W. 1, England

1963

May 26–29	**Twenty-third Annual Meeting of the Institute of Food Technologists, Cobo Hall, Detroit, Michigan**

An open invitation is extended to readers of FOOD TECHNOLOGY to send in to the Editorial Office, P. O. Box 164, Davis, California, notices of annual or national meetings of interest to food technologists.

Industry News

U. S. FOOD INDUSTRY IN PRACTICAL FOREIGN AID

The opening this summer of the Borden Company powdered-milk plant at Mallow, County Cork, Eire, added $840 thousand dollars to a growing overseas investment in a network of manufacturing units operated by U. S. food companies.

The U. S. Commerce Department estimates U. S. spending abroad for new plants and equipment by private industry will total $4.5 billion in 1961; a 20 percent increase over last year.

In the past four months, General Foods Corporation has acquired one Australian and three European firms, at an estimated cost of $7 to 10 millions.

Campbell Soup Company invested $5.6 millions for expansion abroad during the fiscal year ending July 31.

Corn Products Company will have invested $15 millions during 1961 in new facilities in Brazil, Chile, Venezuela, and Japan.

H. J. Heinz Co. received about two-thirds of its earnings in the fiscal year ended March 31 from overseas operations. Two years ago, Campbell Soup opened its first plant in the United Kingdom. The unit's first-year sales, of $7.5 millions, were two and a half times over advance estimates. Plant capacity is now being doubled.

Corn Products is presently introducing mayonnaise and peanut butter to Mexico. It is also in the process of changing centuries-old cooking practices in Germany and England through its rapidly rising marketings of corn oil in those two countries. The company now has 45 factories in 20 countries. Its foreign sales now amount to more than $250 millions yearly. In 1960, 41 percent of Corn Products' net income was earned outside the U. S.; up from 27 percent in 1956.

Foremost Dairies is actively expanding its foreign operations, which in 1960 accounted for about 10 percent of its total sales. Foremost has plants in the Far East, Turkey, Greece, and Spain, where it recombines milk that is shipped as fats and dry solids from the U. S. Ice cream and other dairy products are also manufactured in some units. This year, Foremost opened plants in Teheran and Manila.

On the list of foods processed overseas by U. S. companies, dairy products rank among the principal items. Borden's claims its "Klim," a powdered whole milk, is the most widely known U. S. food product outside this country. It is sold in more than 100 foreign countries.

Standard Brands, Inc., in a joint venture with General Milk Co., last year expanded its powdered skim milk operations in Brazil to the manufacture of powdered whole milk. Standard Brands does not process powdered milk in the U. S. It has plants in 16 foreign countries, processing such items as yeast, coffee, and puddings. Sales for these foreign subsidiaries totaled $28 millions in 1960. The company also has licensing arrangements in several other countries.

By the end of 1961, the Kellogg Co. will have breakfast-cereal-producing units at 21 locations in 17 countries. A plant went into production last summer; another is being completed in Brazil. Units in Finland, Switzerland, and Colombia began manufacturing cereals in 1960.

British housewives are rapidly becoming familiar with cake and pastry mixes. Since 1960, General Mills' British subsidiary, acquired in 1959, has introduced 13 "Betty Crocker" cake mixes in England, and began marketing four new breakfast cereals last spring. In Latin America the company has expanded the output of flour-milling plants in both Venezuela and Guatemala.

National Biscuit Co. also sees an overseas market for its bakery and biscuit products. Last spring the company paid $3.5 millions for a bakery in Puerto Rico, and acquired a leading French biscuit company. In the United Kingdom the company is adding snack items to its product line. In Italy, it hopes to do its own manufacturing in place of a present licensing arrangement. In 1960, the company also invested $5.6 millions for the purchase of a multi-plant company in Australia and New Zealand.

Pillsbury has purchased a 60 percent interest in a $3 million flour mill now being built by the Government of Ghana.

California Packing Corporation this year started packing fruit and tomato products in Italy's Po Valley. In 1960, it established a fruit and vegetable plant in South Africa, a tomato and chili products operation in Mexico, a fruit-nectar-packing unit in Venezuela, and a can-making plant in Canada.

Global expanion of the U. S. food industry is an important factor in international relations, and in the solution of some local problems in the areas in which U. S. capital is invested. The building and operation of food-manufacturing facilities abroad have a far-reaching effect upon the people of a country in terms of physical and economic improvement. Furthermore, this important development will have its direct effect on the teaching and training of future food scientists and technologists.

International Trade

CZECHOSLOVAKIA EXPORTS UP

Czechoslovak Foreign Trade, monthly publication of the Czechoslovakian Chamber of Commerce, reports increased activity in the exports of aromatic substances and milk products.

The Czechoslovak foreign-trade corporation KOOSPOL is quoted as saying that the production of essences and concentrates has increased considerably in recent years, and that a product named Arovanillon has met with great success on foreign markets.

KOOSPOL also reports that Cuban food-industry representatives have recently visited Czechoslovakian plants to negotiate the purchase of essences and concentrates.

The publication also carries an item reporting that in 1960 the export of milk products rose 20 percent over 1959. According to the publication, cheeses are exported

mainly to Egypt and Lebanon, particularly the special "akawi" cheese. Smaller quantities are exported to Germany and Austria, where the Czech "brynza" sheep cheese is in great demand. Dried and condensed milks are exported mainly to the Far East, especially to Indonesia, Ceylon, Cambodia, and Singapore.

Education

NORTH CAROLINA STATE COLLEGE ESTABLISHES DEPARTMENT OF FOOD SCIENCE AND PROCESSING

A wide range of research projects formerly conducted in the North Carolina State College departments of animal industry, horticulture, and poultry science have been transferred to the newly created Department of Food Science and Processing.

Establishment of the new department within the School of Agriculture followed an extensive national study that finally culminated in the decision to reorganize personnel and programs in the food and nutrition area into a single department.

The reorganization will focus attention on the advancement of food processing in the State, and the training of students for vital industrial jobs, research services, and an expanded adult-education program.

Dr. William M. Roberts, formerly head of the Dairy Manufacturing Section of the Animal Industry Department, heads the new department.

The following research, teaching, and extension staff members have been transferred to the Department of Food Science and Processing: Dr. L. W. Aurand, professor of dairy manufacturing; Dr. T. N. Blumer, professor of animal husbandry; J. A. Christian, animal husbandry extension specialist; H. B. Craig, instructor of animal husbandry; Dr. Daniel Fromm, research associate professor of poultry science; Dr. M. W. Hoover, professor of horticulture; Dr. Ivan Jones, research professor of horticulture; Dr. Robert Redfern, assistant professor of dairy manufacturing; Frank B. Thomas, processing extension specialist; Dr. Fred G. Warren, associate professor of dairy manufacturing; and Dr. M. L. Speck, professor of dairy manufacturing.

THE EDUCATION DOLLAR IN CALIFORNIA

Some of the real problems of the financial future of the State of California are represented by the capital investment required to meet anticipated enrollments at the University of California and the state colleges for the next decade. University enrollment will double, and state-college enrollment will triple in that time, calling for respective capital investments of 353 and 128 million dollars.

With support money, the University of California will require 2.7 billion dollars, and the state colleges 1.9 billion dollars in all.

By 1965, if present population trends continue, California will be the most populous in the Union. California, with a population of over 15 million today, will reach a population of 30 million by 1980, and 60 million by the year 2020.

U. C. FOOD SCIENCE SEMINARS SCHEDULED

A series of seminars titled "Vanguards of Food Science" will bring a distinguished group of scientists to the University of California's Davis campus over the next four months.

Sponsored by the Department of Food Science and Technology, the series will include a wide range of topics of both scientific and industrial importance.

The seminars will be held in Room 100, Hunt Hall, at 4:10 P.M. on the dates listed below. Speakers and their topics include:

Sept. 29—Samuel A. Goldblith, Massachusetts Institute of Technology, "The Feasibility of Preserving Food by Irradiation."

Oct. 6—Stuart Patton, Pennsylvania State University, "Flavor Problems in Milk Products."

Oct. 13—Glenn G. Slocum, Food and Drug Administration, Dept. Health, Education, and Welfare, "Food-Poisoning Problems — Old and New."

Oct. 20—Elwyn T. Reese, Quartermaster Research and Engineering Command, "Microbial Attack of Beta-linked Glucans."

Oct. 27—H. L. A. Tarr, Fisheries Research Board of Canada, "Biochemical Changes in Fish Muscle during Storage."

Nov. 3—Ralph T. Holman, The Hormel Institute, "Essential Fatty Acids."

Nov. 10—James F. Bonner, California Institute of Technology, "Microsomal Particles."

Nov. 17—Arthur P. Rinfret, Linde Company, "Cryobiology."

Dec. 1—A. Howard, Commonwealth Scientific and Industrial Research Organization, Australia, "Influence of Pre-slaughter Treatment on Meat Quality."

Dec. 8—William A. Bonner, Stanford University, "Structure and Physiological Behavior of Tremetol."

Dec. 15—Carl Pfaffman, Brown University, "The Sensory and Motivating Properties of the Sense of Taste."

Jan. 5—William J. Darby, Vanderbilt University, "Problems of Nutrition and Malnutrition in the World Today."

Jan. 12—Rockefeller Institute, "Studies on the Structure of Proteins: Pancreatic Ribonuclease."

UNIVERSITY OF NEW ZEALAND RECOGNIZES THE TREND

The University of New Zealand, and its Massey Agricultural College, has abandoned the degree in Dairy Technology leading to the Bachelor of Science, and has instituted a four-year course of Bachelor of Food Technology.

The Dairy Technology Department has now been included in the new Food Technology Department. A new building, which will incorporate food science laboratories and a food-processing section, is under construction.

Professor J. K. Scott, formerly Chief Research Engineer at the Dairy Research Institute and a specialist in food engineering related to heat and mass transfer, will head the new department.

Last Call For Contributed Papers

IFT 22nd ANNUAL MEETING
MIAMI BEACH, FLORIDA
JUNE 10-14, 1962

DEADLINE FOR TITLES AND ABSTRACTS . . . . . JANUARY 15, 1962

All IFT members are cordially invited to submit original research papers dealing with any aspect of food science or technology, for the consideration of the 1962 Program Committee. Please use the tear form below to submit titles and other pertinent information as soon as possible.

Abstracts should be submitted in *triplicate* either with the tear sheet or at any subsequent time before the deadline. Use regular $11 \times 8\frac{1}{2}''$ paper and give title and author(s) on the abstract sheet. The abstract itself should be **double-spaced** and not more than 250 words in length. It should be a concise but accurate and informative summary of the results and conclusions as well as the objectives of the research.

Manuscripts may be submitted as soon as completed to Dr. George Stewart, Editor of *Food Science* and *Food Technology*, so that the papers may be reviewed and cleared for publications following the meeting. All papers not previously submitted to the Editor must be turned over to the chairman of your session at the Annual Meeting.

TEAR SHEET—CLIP AND MAIL TO:

DR. BETTY M. WATTS, Program Chairman
Dept. of Food & Nutrition
Florida State University
Tallahassee, Florida

Title:

Author(s)
(Circle IFT members, underline person who will deliver paper).

Address:

Abstract: Indicate if mailed to another committee member_____

Time required. _____ min. (No contributed paper will be allotted more than 20 minutes, including 5 minutes for discussion. If you can present your material adequately in less time, please indicate.)
Facilities needed: $2 \times 2''$ slide projector ( ), $3\frac{1}{4} \times 4''$ slide projector ( ), blackboard ( ), other

_____

I have read the IFT regulations (page 48) regarding papers to be presented at Annual Meetings and agree to abide by these terms.

_____
Signature

(over)

RULES GOVERNING PAPERS PRESENTED AT ANNUAL MEETINGS

• No submitted paper shall be presented at an Annual Meeting unless at least one of the authors is a member in good standing of the Institute of Food Technologists.

• No paper shall be presented at an Annual Meeting which has previously been given before other group(s), or which has appeared in print prior to the Meeting.

• The Institute shall have first right to publish papers presented at an Annual Meeting of the Institute. However, after a paper has been accepted for the Meeting program, the author may, with supporting evidence, request its release, either before or after oral presentation. Under no circumstances shall release, if granted, permit publication of the paper before the oral presentation. Within fewer than 60 days after receiving a request for release of and the complete manuscript, the Institute through the Executive Editor of its publications shall give the author a decision to release the paper or to accept it for publication subject to the necessary editorial revision. If accepted, the author or authors shall assign all rights in the paper to the Institute, and after publication, the Institute shall, upon request, reassign all rights back to the author or authors.

Y'ALL COME
MIAMI BEACH '62

Just a reminder. Now is the time to start thinking about attending the 22nd Annual Meeting, at Miami Beach, June 10–14, 1962.

After attending sessions and looking over the exhibits, you are sure to enjoy relaxing in Miami Beach and the world-famous Fontainebleau and Eden Roc Hotels. You might want to make attendance at this Annual Meeting part of your vacation. More later. We'll be looking for you—so Y'ALL COME!

To assist the Program Committee in scheduling, please check all categories below which apply to your contribution.

Commodity

- ☐ Meat
- ☐ Fish
- ☐ Dairy
- ☐ Eggs
- ☐ Fruits & nuts
- ☐ Vegetables
- ☐ Fats & oils
- ☐ Cereals, starches
- ☐ Sugars, confectionery
- ☐ Other

Processing

- ☐ Refrigeration
- ☐ Freezing and dehydrofreezing
- ☐ Canning
- ☐ Dehydration and freeze drying
- ☐ Radiation
- ☐ Brining
- ☐ Cooking
- ☐ Packaging
- ☐ Curing
- ☐ Distribution
- ☐ Other

Aspects emphasized

- ☐ Biochemical, (underline proteins, lipids, carbohydrates, enzymes, pigments, flavors)
- ☐ Biophysical
- ☐ Nutritional
- ☐ Microbiological
- ☐ Morphological
- ☐ Rheology, texture
- ☐ Sensory evaluation
- ☐ Quality control
- ☐ Engineering, apparatus
- ☐ Economics
- ☐ Other

MICHIGAN STATE ADVISORY COMMITTEE FORMED

The newly formed Food Industry Advisory Committee to the Department of Food Science at Michigan State University held its initial meeting in August to discuss the department's teaching, research, and extension programs.

The East Lansing meeting, conducted by Dr. Bernard S. Schweigert, department chairman, was devoted to the orientation of both the Committee and the Food Science staff. The undergraduate program in food science was also reviewed.

Representing major food and allied industry groups in the state of Michigan, the Committee is composed of outstanding scientific and executive leaders, and includes:

A. Clausi, General Foods Corp., Battle Creek; Francis Erickson, Michigan Fruit Canners, Benton Harbor; Fay Ewbank, Michigan Milk Producers Assn., Imlay City; Albert E. Hildebrand, H. J. Heinz Co., Holland; William E. Mahaffey, Whirlpool Corp., Benton Harbor; Gary Morgan, John C. Morgan Co., Traverse City; R. C. Newton, Swift and Co. (retired), Three Rivers; Howard Spencer, Dow Chemical Co., Midland; R. D. Stearns, Peet Packing Co., Saginaw; J. J. Thompson, Kellogg Co., Battle Creek; Ray Wakefield, Gerber Products Co., Fremont; Dale Weber, Heatherwood Farms, Lansing; and Francis Witek, Shedd-Bartusch Inc., Detroit.

Conferences

FAO INTERNATIONAL CONFERENCE ON FISH IN NUTRITION

Attended by more than 300 delegates and visitors from the U. S. and 35 other FAO member nations, an International Conference on Fish in Nutrition was held in Washington recently.

The conference marked the first time that an international group of such divergent interests had met to discuss all facets of using fish as food and feed. A broad area of subject matter was presented, ranging from the potential availability of supplies from world fisheries to the use of fish products in reducing the incidence of cardiovascular diseases.

The FAO Conference again pointed to the lack of protein as being the world's most significant nutritional deficiency, and to fish as one answer to the problem. Fish protein has high quality and not only can act as a primary source of amino acids but, in small amounts, can improve the quality of cereal and other plant proteins. It was also pointed out that 95 percent of the world's fish-meal production was used in the United States and other countries where the incidence of malnutrition is lowest.

Fish are also valuable sources of vitamins and minerals, and the lipids may have nutritional significance not yet widely recognized. The highly unsaturated character of the fatty acids leads to easy oxidation, the effects of which need much further study, particularly if fish meals are to be used in human feeding.

During the sessions, new information was presented on the role of fish enzymes in post-mortem changes, and on the nature of fish mitochondrial lipids, which contain very low amounts of essential fatty acids.

Conference speakers dealing with raw materials revealed that the present world production of finny fish is slightly under 30 million metric tons. Estimates of the total possible yield varied from 2 to 10 times the present catch. Intensive cultivation of coastal and inland waters could give much greater yields. New methods of harvesting and processing must be developed if fish products are to be delivered to the growing populations needing them.

Considerable conference time was devoted to the discussion of fish flours, their manufacture, nutritive value, the difficult methods for measuring quality, costs of production, the incorporation of fish flour into already acceptable foods as the best way of supplementing diets in malnourished groups, and acceptability in various countries. Experimental fish-flour plants are operating in the U. S., South Africa, Sweden, Chile, and Morocco.

The FAO Conference served to stimulate thinking about those areas of knowledge that require future attention, and to emphasize that much can be accomplished to allevate world protein deficiency with fish by putting into practice the scientific and technological information presently available. In this regard, many conferees urged that publications on the results of research be improved in relation to details on analytical methods, and the source of raw materials.

Ludgate House, London, will publish the abridged and edited proceedings of the Conference, including all reports and discussions.

Selected Titles

The following is included for those who may have missed announcements of the many conferences held both in this country and abroad. Conference, paper and senior author, and addresses of the sponsoring group or individual to which further enquiry may be made are given. *Food Technology* is NOT a source for obtaining the papers listed.

The Society for Analytical Chemistry, 14 Belgrave Square, London, S.W.1. Program of Meetings for the Session 1961–62, including meetings of the Local Sections and Subject Groups of the Society.

Society Meetings.—Dec. 15, 1961. Joint Meeting with Infra-red Discussion Group on "The Application of Infra-red Spectroscopy to Problems of Analytical Chemistry."

Feb. 18, 1962. Meeting on "New Analytical Reagents in Colorimetric Analyses."

May 2, 1962. Meeting on "The Determination of Sterols."

March 7, 1962. Annual General Meeting, Midland Hotel, Manchester.

North of England Section.—Sept. 30, 1961. "Some Analytical Problems in the Baking Industry." R. A. Knight.

Oct. 27, 1961. "The Analysis of Edible Oils Contaminated with Synthetic Ester Lubricants." G. B. Crump.

Dec. 1, 1961. "The Design and Construction of Laboratories." R. R. Young.

Jan. 27, 1962. "The Work of the Laboratory of the Government Chemist." D. T. Lewis.

Apr. 6, 1962. Joint Discussion on "The Assessment of Psychostimulants."

Scottish Section.—Oct. 6, 1961. "Pentaerythritol." Speakers, A. W. E. Staddon and A. F. Williams.

Nov. 15, 1961. "Recent Developments in Chromatography on Cellulose and on Ion-exchange Cellulose." N. F. Kember.

Dec. 8, 1961. "The Structure of Natural Products by Direct X-ray Analysis." J. M. Robertson.

Feb. 23, 1962. "Death from Poison." A. C. Hunt.

Mar. 23, 1962. "The History of Food Technology." T. McLachlan.

Western Section.—Dec. 8, 1961. "Analytical Research." J. Haslam.

Mar. 16, 1962. "Fluorescence." Speakers, R. J. Otter and C. A. Parker.

Apr. (date unannounced), 1962. Two-day Meeting on "Sampling."

Midlands Section.—Oct. 10, 1961. "Research Work in Analytical Chemistry at the Technical University of Budapest." L. Erdey.

Oct. 22, 1961. "Aquametry." J. H. Thompson.

Jan. 10, 1962. "Developments in Gas Chromatography as Applied to Polymers." Symposium speakers, D. H. Destry, C. A. Finch, and R. S. Lehrle.

Feb. 14, 1962. "Automatic Methods in the Analytical Laboratory." I. D. P. Wootton.

Mar. 29, 1962. "Applications of Radioisotopes in Analysis." D. Gibbons.

Physical Methods Group.—Oct. 24, 1961. Meeting on "Determination of Particle Size."

Feb. 27, 1962. "Some Surface Effects in Electro-analytical Chemistry." H. A. Laitinen.

Biological Methods Group.—Feb. 21, 1962. Meeting on "Assessment of Antibiotics in Animal Feeds."

University of California School of Medicine. Symposium on "Alcohol and Civilization." Nov. 11-13, 1961. (Requests for papers should be directed to the speakers.)

"The Metabolism of Alcohol." Dr. Leonard Goldberg, Dept. Alcohol Research, Karolinska Inst., Stockholm, Sweden.

"Alcohol and Nutrition." Dr. Claudia Balboni, International Center for Psychodietetics, Rome, Italy.

"The Influence of Alcohol on Metabolism." Olof A. Forsander, Dept. Physiology, Research Labs State Alcohol Monopoly, Helsinki, Finland.

"Clinical Value of Alcohol." Dr. Wm. Dock, State Univ. New York Downstate Medical Center, Brooklyn, N. Y.

"The Antiquity of Alcohol as a Beverage." Dr. Salvatore P. Lucia, Univ. California School of Medicine, San Francisco, Calif.

"Alcohol and the Law." John P. Murtagh, Chief Justice, Court of Special Sessions, New York, N. Y.

"Drinking Habits and Their Social Function." Kettil Brunn, Finnish Foundation for Alcohol Studies, Helsinki, Finland.

Literature

WILEY AND INTERSCIENCE MERGE

John Wiley and Sons, Inc., and Interscience Publishers, Inc., formally merged in early October, 1961.

The merger establishes one of the world's largest publishing houses devoted entirely to the production of books and journals in the various fields of natural and behavioral sciences, technology, and engineering. It will also add more than 650 scientific and technical reference works to Wiley's current list of over 1800 titles.

All operations of the two companies will be integrated in the Wiley Building, 440 Park Avenue South, New York.

The Interscience publishing program will continue as a Wiley division.

TRANSLATIONS OF RUSSIAN LITERATURE

The United Kingdom Department of Scientific and Industrial Research keeps abreast of Soviet technical progress through its Russian Translating Program.

Seventeen of the leading Russian technical journals are translated into English, and published monthly. These provide current information on Soviet progress in steel manufacture, castings, welding, rubber and plastics, production engineering, machines and tooling, instrument construction, textiles, wood processing, chemistry, biology, and mathematics.

The Department also sponsors the translation and publication of Russian technical books.

The translating and publishing activities are part of a joint operation of D.S.I.R. and the U. S. National Science Foundation.

Additional information on this service may be obtained from the Director, National Lending Library for Science and Technology, Boston Spa, Yorkshire, England.

Books

A Chemical Approach to Food and Nutrition. 1961. Brian A. Fox and Allang Cameron. University of London Press Ltd., Warwick Square, London, EC4, 30S.

Pressurized Packaging (Aerosols) 2d ed. 1961. A. Herzka and J. Pickthall. Academic Press, Inc., 111 Fifth Avenue, New York 3, N. Y., Butterworth & Co., 88 Kingsway, London, WC2, $15.00.

New Results in Science and Technology of Fruit Juices. Proceedings of the Scientific Technical Commission. 1961. Wageningen, Holland, Juris-verlag, Zurich, Switzerland.

A Guide to the Selection, Combination and Cooking of Foods, Vol. 1. 1961. Carl A. Rietz, The Avi Publishing Company, Inc., Westport, Connecticut. $15.00, foreign $16.00.

Seeds, The Yearbook of Agriculture. 1961. Alfred Stefferud, ed., U. S. Department of Agriculture, Washington, D. C.

The Chemical and Biological Action of Radiations, Volume V. 1961. M. Haissinsky, ed. Academic Press, Ltd., 17 Old Queen Street, London, S.W.1, Masson et Cie., Editeurs, 120 boulevard Saint-Germain, Paris-VI, France.

Aktuelle Probleme des Mineralstoffwechsels, Supplement I, Journal of Nutritional Science. 1961. W. Auerswald and H. Frenzel-Wien, Dr. Dietrich Steinkopff Verlag, Darmstadt, Germany.

The following may be obtained from The Graduate School, U. S. Dept. of Agriculture, Washington 25, D. C.

Promise of the Life Sciences, $1.50. Five lectures by eminent scientists covering advances at the frontiers of biological research. The titles Biological Transformation of Energy; Genetics; Nutrition—the Chemistry of Life; Fine Structure and Pattern of Living Things; and The Organism and the Environment.

The International Age in Agriculture dealing with the world's food supply, surplus foods, and technical and economic aid.

The following books are 1961 offerings of the University of Chicago Press, 5750 Ellis Avenue, Chicago 37, Ill.

A Handbook of Biological Illustration, Frances W. Zweifel. $1.95. Intended to help the biologist who is not also an artist prepare illustrations for publication, and to aid the illustrator who is not a biologist prepare biological renderings.

Basic Physiology, Fred E. D'Amour. $7.95. A basic text in physiology designed so that it may be adopted for a variety of courses. Particularly well suited for the advanced high school course, the junior college, or the university survey course. References are completely up to date, and there are numerous illustrations.

Physiological and Behavioral Aspects of Taste, Morley Kare and Bruce P. Halpern. $6.00. A summary of new and very technical work on the diverse roles of taste.

Journals

Czechoslovak Foreign Trade, Vol. 1, No. 7, July 1961. (Published monthly in English, French, German, and Spanish by the Chamber of Commerce of Czechoslovakia. U. S. reps. Stecher and Hafner, Inc., 31 E. 10th St., New York 17; 50 cents a copy). Of interest in this issue: State Budget of the Czechoslovak Socialist Republic in 1961; World Trade and East-West Trade; Czechoslovak Agriculture; and Prospects of Development of Czechoslovak Trade Relations with Cambodia, Indonesia, and the United Arab Republic.

Miscellaneous

Mark, Vol. 3, No. 1, monthly newsletter of CIBA Pharmaceutical Products Inc., P. O. Box 195, Summit, New Jersey. Free. While newsletter is intended primarily for use by high school teachers, this issue includes a world map showing those areas in which the population is undernourished.

Bulletins

The World Food Budget, 1962 and 1966, Foreign Agricultural Economic Report No. 4, Oct. 1961. Office of Information, U. S. Dept. Agriculture, Washington 25, D. C. Free. A world food-budget study projecting world food production, imports, expected consumption, and the minimum level above expected consumption to give the world's people an adequate diet for normal health and activity.

Laboratory Manual for Dairy Microbiology, 3d ed. 1961. E. M. Foster and W. C. Frazier. Burgess Publishing Company, 426 South Sixth Street, Minneapolis 15, Minn. $3.00.

Industrial Skin Packaging. 1961. F. C. Steng. Union Carbide Development Company, 270 Park Avenue, New York 17, N. Y. Free.

Proceedings of the Thirteenth Research Conference sponsored by the Research Council of the American Meat Institute Foundation. 1961. Circular No. 64. American Meat Institute Foundation, 939 East 57th Street, Chicago 37, Illinois.

Roots High-vacuum Booster Pumps. 1961. Roots-Connersville Blower. Charles N. Graff and Associates, Inc., P. O. Box 396, Olean, N. Y.

Suggested Flowsheet Instrumentation Symbols. Feb. 1961. Bull. 91-53G-02. Fischer & Porter Company, 946 Jacksonville Road, Warminster, Pa.

Niagara "No-frost" Continuous Production Food Freezing. August 1961. Niagara Blower Company. 425 Franklin Street, Buffalo 2, N. Y.

Can the Industrial Research Scientist Acquire a 'Management Attitude?' M. R. Nestor. Battelle Memorial Institute, Columbus 1, Ohio.

Hooker Chemicals. 1961. Bulletin 100-E. Hooker Chemical Corporation, P. O. Box 326, Jeffersonville, Ind.

Hyamine 1622 and Hyamine 10-X. June 1961. Rohm and Haas Company, Washington Square, Philadelphia 5, Pa.

B-I-F for Controlled Feeding of Liquids and Solids. July 1961. B-I-F Industries, Providence, Rhode Island.

De Laval Catalog of Self-cleaning Centrifuges. August 1961. De Laval Separator Company, Poughkeepsie, N. Y.

Panelcoil. Technical Data Bulletin 356. Dean Products, Inc., 1042 Dean Street, Brooklyn 38, N. Y.

U.S.I. Ethylene, Refined. 1961. U. S. Industrial Chemicals Co., 99 Park Avenue, New York 16, N. Y.

Buflovak's Catalogue 393. Evaporators. Blaw-Knox Company, P. O. Box 2041, Buffalo 5, N. Y.

Blow Molded High Density Polyethylene Containers — Collapse Problems and Recommended Solutions. Technical Service Bulletin 109. W. R. Grace & Co., 225 Allwood Road, Clifton, N. J.

Annual Report 1960–61. Commonwealth Scientific and Industrial Research Organization, Division of Food Preservation. July 1961. P. O. Box 43, Ryde, N. S. W., Australia.

Handling and Merchandising Frozen Food. A Manual for State Extension Personnel. F. Miles Sawyer, Thaddeus F. Midura, and Richard M. Vondell. Food Distribution Program. Cooperative Extension Service, University of Massachusetts, Amherst, Mass. Free.

Annexe 1960–3 Supplément au Bulletin de l'institute International du Froid. International Institute of Refrigeration, 177 Boulevard Malesherbes, Paris (17e), France.

Providing U. S. Scientists with Soviet Scientific Information, revised edition. May 1959. Office of Science Information Service, National Science Foundation, Washington 25, D. C.

Food Applications of Fully Refined Light Hydrocarbon Distillates. Current Topics No. 150. White Oil Division, Sonneborn Chemical and Refining Corp., 300 Park Avenue, South, New York 10, N. Y.

Norelco X-ray Analytical Instrumentation. June 1961. Philips Electronic Instruments, 750 South Fulton Avenue, Mount Vernon, N. Y.

Visual Aids for Sanitation Training and Education. Technical Bulletin. Institute of Sanitation Management, 55 West 42nd Street, New York 36, N. Y.

Annual Report of Steel and Tin Consumed in Metal Cans. 1961. Can Manufacturers Institute, 821 15th Street, N. W., Washington 5, D. C.

The Effect of Standard Cooking and Processing Methods on the Nutritional Value of Meat Protein. A. J. Siedler. Bull. No. 51. Division of Information and Service, American Meat Institute Foundation, 939 East 57th Street, Chicago 37, Illinois.

Becco Bulletin List. July 1961. Becco Chemical Division, FMC Corporation, 161 East 42nd Street, New York 17, N. Y.

Aldehydes. Union Carbide Chemicals Company, 270 Park Avenue, New York 17, N. Y.

Coffee Drinking in the United States. 1961. Pan-American Coffee Bureau. 120 Wall Street, New York 5, N. Y.

Turning Point in Bacon Contracting. 1960. S. Gruszecki, A. Proczkowski, M. Radomski (translated from Polish). Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. 50 cents.

Some Facts About California Agriculture. 1961. D. M. Rutherford and Kenneth R. Farrell. University of California Agricultural Extension Service, Berkeley 4, California.

The Consumer Looks at Deceptive Packaging. 1961. Clinton L. Warne. Council on Consumer Information, Colorado State College, Greeley, Colorado. 50 cents.

The Hurty-Peck Library, a bibliography of books and booklets on beverages, their history and manufacture. 1961. Compiled by A. W. Nbling. Hurty-Peck & Company, Indianapolis, Indiana.

U.S.D.A. Summary of Registered Agricultural Pesticide Chemical Uses, supplement II. June 1, 1961. Pesticides Regulation Branch, Agricultural Research Service, U. S. Department of Agriculture, Washington, D. C.

Physical Properties, Synthetic Organic Chemicals. 1961 ed. Union Carbide Chemicals Company, 270 Park Avenue, New York 17, N. Y.

Wine Institute Sanitation Guide for Wineries. 1961. Almond D. Davison. Wine Institute, 717 Market Street, San Francisco 3, California. $5.00.

UNICEF Compendium, Vol. VII. United Nations Children's Fund, UNICEF, United Nations, New York, N. Y.

Respiratory Devices for Protection Against Inhalation Hazards of Dust, Mists, and Low Vapor Concentrations of Certain Pesticides. H. L. Haller. U. S. Department of Agriculture, Agricultural Research Service, Washington 25, D. C.

The Torbal B. T. L. Anaerobic Jar. August 1961. Torsion Balance Company, Clifton, N. J.

Ultraviolet Visible–Near-Infrared Spectrophotometer Bibliography. Bulletin 795. 1961. Technical Information Department, Beckman Scientific and Process Instruments Division, Fullerton, California.

MP-12 Analogger. 1961, Republic Flow Meters Company, 2240 Diversey Park-

way, Chicago 47, Illinois. Toronto, Ontario.

Fostoria Radiant Heat. Fostoria Corporation, Dept. 109, 1200 N. Main Street, Fostoria, Ohio.

The Common Chemical Market. Oct. 1961. Foster D. Snell, Inc., 29 West 15th Street, New York 11, N. Y. $18.00.

Nutrition and Radiation Injury, An Annotated Bibliography. July 1961. Doris Howes Calloway and Lore Rose David. Library Bulletin No. 6. Quartermaster Food and Container Institute for the Armed Forces, Chicago 9, Illinois.

Second Annual Research Conference. Dried Fruit Research Industry Advisory Committee. 1961. Dried Fruit Association of California, P. O. Box 618, San Jose, California.

The Canadian Food Industries in National Survival, July 1960, Joseph H. Hulse and Jane White, Defense Research Medical Laboratories, P. O. Box 62, Postal Station "K", Toronto, Canada.

Consumer Purchases of Citrus and Other Juices. January 1961, Clive E. Johnson, Agricultural Marketing Service CPFJ-113, U. S. Department of Agriculture, free.

Strontium 90 in Milk and Agricultural Materials in the United Kingdom, 1961, Agricultural Research Council Radiobiological Laboratory Report No. 4, British Information Services, 45 Rockefeller Plaza, New York 20, N. Y., 95 cents.

A Survey of Poultry Meat Sales in Georgia Restaurants, March 1961, Harold B. Jones and Kenneth N. May, Georgia Agricultural Experiment Stations, University of Georgia, Athens, Georgia, free.

Marketing Commercial Eggs in Georgia, April 1961, Harold B. Jones, Georgia Agricultural Experiment Stations, Bull. N. S. 83, University of Georgia, Athens, Georgia, free.

U.S.D.A. Summary of Registered Agricultural Pesticide Chemical Uses, Supplement 1, Instructions for Making Changes and Additions, March 1961, Department of Agriculture, Agricultural Research Service, Washington 24, D. C., free.

Precision Plastics and Composites for Industry, 1961, Manager of Government Relations and Marketing, Raytheon Aero/Weapons Division, 520 Winter Street, Waltham, Massachusetts, free.

Proceedings Flavor Chemistry Symposium, 1961, Campbell Soup Company, Camden, N. J.

Field Stations and Experimental Areas, June 1961, James L. Myler, California Agricultural Experiment Station, University of California, Berkeley, California, free.

The Composition of Milk in Manitoba, 1961, A. Reinart and J. M. Nesbitt, Department of Dairy Science, University of Manitoba, Winnipeg, Manitoba, free.

The Etiology of Pork Tongue Abscesses, March 1961, J. N. Campbell and C. F. Niven, Jr., Bulletin No. 46, American Meat Institute Foundation, 939 East 57th Street, Chicago 37, Ill., free.

Heat Transfer Thermal Insulation Instrumentation, International Institute of Refrigeration, June 1960, Yugoslavia, 177 Boulevard Malesherbes, Paris (17°) France.

Performance Capacity, a Symposium, February 1961, Edited by Harry Spector, Josef Brozek, and Martin S. Peterson, Advisory Board on Quartermaster Research and Development, Committee on Foods, Quartermaster Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago, Illinois, free.

Operating Data Monthly, Feb. 1960, Editor, J. R. Kelahan, National Association Practical Refrigerating Engineers, Inc., P.O. Box 1162, Oak Park, Ill., $1.00.

Research at Battelle Memorial Institute, 1961, Battelle Memorial Institute, Columbus 1, Ohio, free.

Die Leybold-Welle, Vol. 1, No. 3–4, 1961, J. Klinger Scientific Apparatus, 82-87 160th Street, Jamaica 32, N. Y., free.

Utilization of Animal Fats, A Technical Review, American Meat Institute Foundation, 939 East 57th Street, Chicago 37, Illinois, free.

Refrigeration Engineering, A Sourcebook of Soviet Literature, 1956, National Science Foundation, Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., $3.00.

A.A.P.G. Slide Manual, 1960. The American Association of Petroleum Geologists, Inc., P. O. Box 979, Tulsa 1, Oklahoma, free.

Patents

(Complete patent specifications are available through L. Janowski, 213 W. Hickory Road, Lombard, Illinois; 25¢ for each United States specification, and $1.00 for each foreign one. Add 15¢ for handling.)

US 2,995,166; Aug. 8, 1961 (C. Burley and John Moffett). A method for removing the skins of raw, edible nuts. Infrared radiation is applied for 4–8 min, raising the temperature to about 150°F. The loosened skins are then blown from the nuts.

US 2,995,446; Aug. 8, 1961 (E. Freed). A process for removing contaminating metal from fruit juice, in which an insoluble, solid, inorganic calcium phosphate compound is added to precipitate the metal ions.

US 2,995,447; Aug. 8, 1961 (R. Cipolla, D. Davis, and C. VanderLinden; Johns-Manville Corp.). Free-flowing dried dairy products. Caking is prevented by dispersing in the whey 0.5–10% by weight of a finely divided, hydrothermically reacted calcium silicate.

US 2,995,448; Aug. 8, 1961 (T. Kew and M. Veldhuis; U. S. Dept of Agr.). Cloud stabilization in citrus juice. A water extract of grape leaves is added, reducing pectin esterase activity and stabilizing "cloud" in reconstituted citrus juices.

US 2,995,452; Aug. 8, 1961 (D. Odegaard, E. O'Brien, and E. Krammer; Armour and Co.). An improved method of preserving ground beef, in which the meat is chilled and promptly stored at 25–42°F in the absence of air.

US 2,996,384; Aug. 15, 1961 (C. Elsesser; General Foods Corp.). An improved cake mix of the shortening-containing type containing 0.01–1% by weight of a water-soluble salt of carboxy-methyl cellulose.

US 2,996,386; Aug. 15, 1961 (E. Levin). A method of processing fish, in which the fish is heated in water prior to comminution to partially convert the collagenous tissue to gelatin without removing the skin.

US 2,996,387; Aug. 15, 1961 (S. Radlove; The Glidden Co.). Edible shortening compositions useful as baking emulsifiers and containing hexitol and hexitan partial esters.

US 2,997,394; Aug. 22, 1961 (D. Melnick, H. Wahlteich, and R. Bohn; Corn Products Co.). Farinaceous, yeast-raised baked products. The dough contains a solid fat-fungistat mixture that is inactive at room temperatures but is activated when the fat melts during baking.

US 2,997,395; Aug. 22, 1961 (N. Berridge; National Research Development Corp., England). A process for the manufacture of cheese curd. A milk and rennet mixture is kept at non-coagulating conditions until the enzymatic action of the rennet nears completion, after which it is rapidly heated and held at a temperature where coagulation of curd and exudation of whey can occur.

US 2,997,396; Aug. 22, 1961 (G. North, P. Noznick and B. Stiritz; The Beatrice Food Co.). A process for making an edible-fat margarine that has discrete fat globules coated with non-fat milk solids dispersed throughout.

US 2,997,736; Aug. 29, 1961 (F. Ine). A vacuum eviscerating device for removing lung, kidneys, and like organs from a body cavity.

US 2,998,316; Aug. 29, 1961 (I. Reich; Standard Brands Inc.). A process for improving the flow characteristics of instant-coffee compositions. Sufficient coffee powder with a high ratio of surface area to unit-weight is blended in to render the final composition free flowing.

US 2,998,317; Aug. 29, 1961 (S. Reesman; General Foods Corp.). Cereal flakes are produced by drying cooked grain pieces at 200–400°F to obtain a moisture content of 13–25%, rapidly cooling to below 120°F, and immediately flaking.

US 2,998,318; Aug. 29, 1961 (J. Forkner; The Pillsbury Co.). A method for the manufacture of a filled cookie. A layer of soft dough is pressed over chilled filler fragments to form areas in the dough layer through which the fragments are visible.

SITUATIONS WANTED

Reply directly to ad BY BOX NUMBER (where indicated) via: Executive Secretary, Institute of Food Technologists, 176 West Adams Street, Chicago 3, Illinois.

TECHNICAL SALES ASSISTANT MANAGER position desired. 11 years experience in technical sales and service, product development, research and quality control with two major food companies. Many research and sales contacts in Middle West. Will do excellent job of moving your products into current and new areas. REPLY BOX 930.

Responsible administrative position desired allied to Engineering, Food Technology, Chemistry and Microbiology. 10 yrs. diversified industrial experience in product, equipment and process development. Report and data presentation experience as well as personnel supervision. M.S. degree. Prefer Western location. Complete résumé upon request. REPLY BOX 927.

FOOD TECHNOLOGIST (M.S.) desires a position in charge of Quality Control and/or Products Development with a medium sized Company. Mature. Extensive background in flavor bases, dairy products, frozen foods. REPLY BOX 936.

Individual thoroughly experienced in canned foods, frozen foods, and management, desires challenging position as plant manager, general manager, or director of research and development. Salary, $15,000. REPLY BOX A-2132.

Executive management position in food production or allied field desired by technical man with experience in production, product development, product promotion and sales. Salary, $12–15,000. REPLY BOX A-2133.

Product development and quality control interest individual who has had experience in demonstrating food products. Her product experience has been with pie fillings, frozen and canned meat, seafood and poultry products. Salary, $6,300. REPLY BOX A-9102.

Advanced degree and experience in product development are qualifications set forth by individual interested in working with poultry and frozen foods. Salary, $7,200. REPLY BOX B-0101.

Experience in teaching and academic research comprise background of individual with degrees in poultry. Desires product development or packaging position. Salary, $7,500. REPLY BOX B-0104.

Position in technical administration or industry research, product development or quality control desired by chemist with business management degree. Has had heavy experience in statistical design of experiments. Salary, $13,000. REPLY BOX B-0103.

Food technologist with advanced business degree desires line management or product development and research position. Experienced in production, product development, engineering and quality control. Salary, $11–15,000. REPLY BOX B-1126.

Individual with advanced degree seeks position involving meats, preferably in the area of academic research. Salary, $9,000. REPLY BOX B-0102.

Fruits and vegetables interest individual with experience in product development and academic research. He desires position as food technologist or chemist. Salary, $8,400. REPLY BOX B-1101.

Position as manager of food technology or production manager-sales, desired by experienced food technologist. Has held responsible position working with the canning, freezing and packaging of numerous products. Salary, $16,000. REPLY BOX B-1104.

Individual with freeze drying experience in meats and fruits and vegetables desires position involving research in dehydration. Salary, $9,000. REPLY BOX B-1105.

Food technologist with experience in meats desires academic teaching post. Salary, $8,000. REPLY BOX B-1107.

Food technologist with production and academic research experience desires position in product development, research, and/or pilot plant operation. Salary, $9,000. REPLY BOX B-1109.

Young food technologist desires research work with poultry, meats or eggs. His interest is in academic or industry research, product development, or quality control. Salary, $7,500. REPLY BOX B-1114.

Individual with advanced degree in food science will work with any product, and desires position involving research in process development and/or methods testing. Salary, $8,500. REPLY BOX B-1117.

Individual experienced in frozen foods and with degrees in food technology and public health desires position as food sanitarian. Salary, $6,500. REPLY BOX B-1118.

Broad product experience and over ten years association with industry are qualifications set forth by individual with advanced degree in food technology. He desires research administration or corporate staff technical assignment. Salary, $19,000. REPLY BOX B-1120.

Food science and technology graduate with R & D experience desires product development, technical service or academic research position. Salary, $7,000. REPLY BOX B-1121.

Individual with twenty years experience in production and quality control, particularly with vinegar and apple juice, desires position in the area of production, management, or research. Salary, $17,500. REPLY BOX B-1122.

Product development or technical service position desired by food technologist with experience in institutional frozen foods. REPLY BOX B-1124.

Advanced degree in food technology and experience in freeze drying development are qualifications set forth by individual who desires position in product development, technical service or packaging. REPLY BOX B-1125.

POSITIONS AVAILABLE

Reply directly to ads BY BOX NUMBER (where indicated), including the company name of your current employer, via: Executive Secretary, Institute of Food Technologists, 176 West Adams Street, Chicago 3, Illinois.

FOOD TECHNOLOGIST
CHEMIST
(B.S.–M.S.)

Interesting and challenging positions in Technical Sales Service. Prefer applicants with experience in confections and/or general food field. Positions consist of (1) technical service contacts with customers from headquarters at Clinton, Iowa, and (2) development of new uses of products in Clinton's modern laboratories. Considerable travel involved.

Replies will be held in strictest confidence. Send résumé and details of education and experience to:

DR. J. M. NEWTON
Director, Technical Sales
Service Department
Clinton Corn Processing Company
Clinton, Iowa

WANTED: Food Chemist—N. Y. City area. For varied analytical work in product improvement and development. Some experience at instrumental level desired. Established Food Manufacturer. REPLY BOX 929.

Senior experimental baker wanted to supervise pilot plant production and work with experimental bakery manager in developing methods for production of new products. Minimum experience required 8 years. Excellent starting salary and outstanding company benefits. Plant located in southwestern Connecticut. Please send résumé and salary history to BOX 926.

Immediate Openings in

PACKAGE QUALITY CONTROL

1) Senior Quality Control Engineer to analyze and verify non-chemical aspects of package quality. Engineering degree plus four years' experience.
2) Pharmacist or Chemist to evaluate chemical effects of pharmaceutical packaging materials. B.S. degree plus two years' experience.

Please reply to Manager, Technical Employment, Mead Johnson & Company, Evansville 21, Indiana.

ALL QUALIFIED APPLICANTS WILL RECEIVE CONSIDERATION FOR EMPLOYMENT WITHOUT REGARD TO RACE, CREED, COLOR OR NATIONAL ORIGIN.

RESEARCH BACTERIOLOGIST

Carry out bacteriological research activity as applied to spoilage, processes, ingredients, and sanitation of food products. Major Pennsylvania located food processor. Ph.D.—recent graduate considered. Send full particulars including salary requirement to BOX 928.

RALSTON PURINA COMPANY

is seeking Ph.D. or experienced FOOD TECHNOLOGIST. Ability to lead in new product development with both creative and application talents. Involves customer service contacts. Write:

L. H. Wahlbrink
Ralston Purina Company
Checkerboard Square
St. Louis 2, Missouri

FLAVOR CHEMIST. B.S. in chemistry. Minimum of 3 to 5 years experience. Duties will be primarily in control and development. Location, middle Atlantic area. Good opportunity in a rapidly growing organization. Our employees know of this ad. Submit complete résumé. Write BOX 935.

RESEARCH LABORATORY MANAGER

Small and young but growing company has an opportunity for a creative food scientist who feels stymied in his present job. Our company is well established, a leader in the field of enzyme application in the food industry.

Education: Ph.D. degree in bio-chemistry or microbiology with concentration in enzymology.

Experience: 2–3 years industrial experience or university experience with industrial research contract.

Personal: Must be capable of accepting responsibility and demonstrate initiative to take charge.

Salary: Top salary commensurate with training and experience. In addition, participation in profit sharing plan.

Location: Attractive residential suburb of Milwaukee, Wisconsin, with excellent grade and high school systems. Close to university and cultural centers.

For an interview write, giving complete résumé of educational background, experience, research interests and salary history to BOX 934.

WANTED: Quality Control Manager for new plant. Top-quality Frozen Bakery Products Company is expanding. Administrative experience essential. Training in Bakery Science, Chemistry, Microbiology, Food Technology or Dairy Science desirable. Relocation to be expected. Salary up to $10,000. Address replies to BOX 933.

FOOD TECHNOLOGIST FOR PROCESS DEVELOPMENT

Required: B.S. degree in Food Technology, Food Engineering, Chemical Engineering or Chemistry. Experience in food industry desirable but not essential. Duties: assist in development of production processes for new products. Salary open. REPLY BOX 932.

NEEDED: Quality Control Manager for Bakery Products Plant of national frozen food company. Opportunity for growth. Challenging work. Liberal fringe benefits. Congenial associates. Previous management experience required. Background in science and foods helpful. Applicant must be ready to move. Salary up to $8,500. Write BOX 931.

RESEARCH FOOD CHEMIST

A leading manufacturer of prepared meats, located in Fort Wayne, Indiana has opening for Research Chemist because of company growth and internal promotions.

Position involves research for development of new products and improvement of existing processes. Well equipped laboratory with pilot plant facilities available.

We prefer a masters degree in food technology or chemistry, but will consider a B. S. degree with suitable background. A minimum of 2 years industrial experience with meat or related foods is required.

Send a detailed résumé with past earnings history to:

Peter Eckrich & Sons, Inc.
Personnel Department
Box 388
Fort Wayne, Indiana

BREWING CHEMIST—Assistant Chief Chemists required for an expanding multi-plant West Coast brewing organization. To assist supervision of quality control laboratory, and special projects while training for advancement. B.S. or M.S. in field offering good background in Chemistry, Microbiology or Food Technology and preferably some Engineering. Some brewery experience required. Applicant must have the personal attributes and desire to advance through company training program to chief chemist and then into production supervision. Unusually fine opportunity for men with initiative and good technical ability. Submit full academic and experience résumé with references in complete confidence to:

HAROLD ROSOFF
Lucky Lager Brewing Company
P. O. Box 3325
San Francisco 19, California

Junior Chemist. Eastern location. Degree in food technology or equivalent required of young individual who will work on new product development and product improvement studies in the field of fruits and vegetables. Salary, $5,400. REPLY BOX X-1214.

Product Research Technologist. Southern location. B.S. in food technology and up to five years experience in a food or related industry required of individual who will plan, conduct, and analyze research studies on new food products. Salary, to $9,000. REPLY BOX X-1502.

Senior flavor chemist. East coast location. Ten years experience and B.S. in chemistry or equivalent, to create and improve flavor compounds in the essential oil field. REPLY BOX X-2206.

Assistant Food Technologist. Eastern location. Degree in chemistry, food technology, or related field plus three to five years experience on heat processed foods. Assist in the development of the formulation through to the production of new lines. REPLY BOX X-2211.

Customer Research Trainee. B.S. with up to two years experience in research or technical service, for position involving service to metal container packaging industry. REPLY BOX X-3305.

Engineer. Western location. Graduate mechanical or chemical engineer with three years experience in design of evaporative and/or distillation equipment necessary. Employee will design evaporators, plus spend twenty percent of the time in an engineering sales capacity. REPLY BOX X-2401.

Plant Superintendent. Midwest location. M.E., I.E., or Chemical Engineer who has graduated in the upper fourth of his class, and has a minimum of five years experience as Assistant Superintendent or Plant Superintendent with proven record of accomplishments. Will supervise 150 production employees in blending operation, and have jurisdiction of purchasing department. Salary, to $15,000. REPLY BOX X-3303.

Research Engineer—Process Development. Midwest location. B.S. in chemical engineering or food technology, and up to five years experience in food or shortening process, required of individual who will work on adaptation of food drying process to provide product samples of various research and development groups. REPLY BOX X-3306.

Research Engineer—Food Engineering Activity (5). Midwest location. At least two years of process development experience and a B.S., M.S., or Ph.D. in chemical engineering or food technology required. Will conduct food pilot plant; plan and conduct new product development research, and perform creative research in food engineering. Salary, $8,500. REPLY BOX X-3307.

Flavor Salesman. Midwest location. Scientific education desired, plus a minimum of five years flavor sales experience. REPLY BOX X-9101.

Technical Director. Midwest location. Five years experience in food technology required of individual who will install and staff new laboratory, administer program of quality control and new product development. REPLY BOX X-9203.

Flavor Research Chemist. Midwest location. B.S. or equivalent and three to five years laboratory experience in flavor development and duplication required of individual who will assume an additional "bench" in new R & D laboratory. Salary, to $12,000. REPLY BOX X-9302.

Perfumist. Midwest location. Five years experience required, preferably in fine perfumery and chemistry, of individual who will be involved in the area of perfuming industrial products such as floor waxes, insecticides, and paints. Salary, $10,000. REPLY BOX X-9305.

Plant Manager. Midwest location. Will manage flavor factory, including requisitioning of raw materials, management of warehouses, scheduling of production, and planning of equipment. Salary, $10,500. REPLY BOX X-9306.

Salesman (2). Midwest or west coast location. B.S. or B.A. and experience in contacting food and beverage manufacturers with raw materials required. Individual selected will contact these manufacturers to service and develop new flavor accounts. Salary, to $11,000. REPLY BOX X-9401.

Flavor chemist. Midwest location. Experienced compounder to aid in flavor development and production. Organoleptic acuity essential. REPLY BOX X-9304.

Flavor Chemist. Midwest location. Five years experience required, preferably in flavoring manufacture and/or chemistry. Knowledge of basic flavoring materials and the compounding thereof, to make concentrated flavoring materials, both natural and synthetic, for all types of industries using flavors. Salary, $11,000. REPLY BOX X-9307.

Product Development and Control. Midwest location. Female with food background in creating, preparing and testing food, preferred. She will use her experience with new and existing frozen cooked food for retail and institutional use. REPLY BOX X-9309.

Sales Representative. Midwest location. B.A. or B.S. with two or three years experience preferred. Position involves technical sales of gums, proteins, and propionates to the food and drug industry. Salary, $7,500. REPLY BOX X9310.

Production Manager. Midwest location. Seek man with background in organic chemistry who will compound flavors from prepared formulas. Will be responsible for quality control and production. Salary, to $7,800. REPLY BOX X-9311.

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